With METALLURGICAL SUPPLEMENT.

SEP 12 1929

The Engineer.

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The Engineer

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PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—
SCHEDULE 1.—95 TONS FISH BOLTS and CHAIR BOLTS.
SCHEDULE 2.—20,000 SACK ELEMENTS, No. 1 Size.
Tenders due as follows :—
Schedule 1, 13th September, 1929.
Schedule 2, 2nd October, 1929.
Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each schedule. 3026

Civil Service Commission.
FORTHCOMING EXAMINATION.
PROBATIONARY ASSISTANT ENGINEERS in the Engineering Department of the Post Office (20-25, with extension in certain cases).
Regulations and particulars, together with the forms on which applications must be made, will be sent in response to requests (preferably by postcard), addressed to the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1. The latest date for the receipt of application forms is 12th September. 2820

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.
APPLICATIONS from qualified candidates are INVITED for the following POST :—
M/1499.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of the GOLD COAST, Public Works Department, for a tour of twelve to eighteen months' service, with possible extension. Salary £480 for three years, then £510, rising to £720 by annual increments of £30, and thence rising to £920 by annual increments of £40. Free quarters and passages and liberal leave on full salary. Transport allowance of £48 a year and outfit allowance of £60 on first appointment. Candidates, 25 to 35 years of age, must have passed examination for Section A and B of the A.M.I.C.E. Diploma or hold professional qualifications accepted by the Institution of Civil Engineers as exempting from those examinations. Must be capable of taking complete charge of the construction of buildings, bridges and roads; a knowledge of land and quantity surveying is necessary as well as experience in measuring up completed work.
Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/1499. 3024

City of Cardiff Education COMMITTEE.
THE TECHNICAL COLLEGE.
PRINCIPAL - CHARLES COLES, B.Sc. (Lond.).
DEPARTMENT OF ENGINEERING.
HEAD OF DEPARTMENT: A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.
SESSION 1929-30.
(Commencing on Monday, 30th September, 1929.)
The following COURSES have been arranged for Engineering students :—
A THREE YEARS' COURSE in MECHANICAL and MARINE ENGINEERING, jointly with the University College of South Wales and Monmouthshire.
A TWO YEARS' COURSE for Apprentices and others, with facilities for practical experience in the Summer Term.
These Courses are suitable for students preparing for Degrees in Engineering or for the Examinations of the Engineering Societies.
Special Courses are also arranged for Marine Engineers preparing for the Examinations of the Board of Trade.
OPEN SCHOLARSHIPS, covering tuition fees and maintenance grants of £40 per annum for three years, are offered for competition annually, and candidates for entry to the above Department are eligible to compete.
For further particulars of Full-time and Part-time Courses, Entrance Examination, Scholarships, Fees, &c., apply to the Principal. Application forms for entrance scholarship examination, duly filled up, must be received before September 14th.
THOMAS McHOWAT, Director of Education, City Hall, Cardiff. 2982

Northampton Polytechnic INSTITUTE,
St. John-street, London, E.C. 1.
SCHOLARSHIPS IN ENGINEERING AND OPTICS.
An examination will be held on September 17th and 18th at the Polytechnic for the award of the following SCHOLARSHIPS :—
THREE SCHOLARSHIPS in ENGINEERING, value £18 per annum.
These scholarships are tenable at courses extending over four years in Civil, Mechanical Electrical or Aeronautical Engineering, and including ten months' practical experience in the Works of large industrial firms.
ONE SCHOLARSHIP in OPHTHALMIC OPTICS, value £18 per annum.
ONE "AITCHISON MEMORIAL" SCHOLARSHIP in OPHTHALMIC OPTICS, value £18 per annum.
For further information apply to :—
S. C. LAWS, M.A., M.Sc., Principal.
2965

Northampton Polytechnic INSTITUTE,
St. John-street, London, E.C. 1.
EVENING CLASSES IN
ENGINEERING.
All branches of Civil, Mechanical, Electrical, Aeronautical, Automobile and Radio Engineering.
APPLIED OPTICS.
Ophthalmic Optics, Optical Instrument Making, Optical Glass Working.
HOROLOGY.
FURRIERY.
APPLIED CHEMISTRY.
Fuels, Electro-plating, Metallurgy, &c.
DOMESTIC AND ALLIED SUBJECTS.
Commence SEPTEMBER 23rd.
ENROLMENTS during week commencing SEPTEMBER 16th.
Free prospectus on application to :—
S. C. LAWS, M.A., M.Sc., Principal.
2966

PUBLIC NOTICES

The Polytechnic, 309, Regent STREET, W. 1.
STUDENTSHIP EXAMINATION OF THE INSTITUTION OF MECHANICAL ENGINEERS.
PRELIMINARY EXAMINATION, INSTITUTION OF CIVIL ENGINEERS.
FINAL EXAMINATION, INSTITUTION OF ELECTRICAL ENGINEERS (PART 1).
Special Courses have been arranged for Students taking the above Examinations. The syllabus covers all the work in PURE MATHEMATICS, MECHANICS, PHYSICS, ENGLISH and FRENCH.
Fee for the course £2 2s.
Prospectus free on application to the DIRECTOR OF EDUCATION. 2913

The Polytechnic, Regent STREET, W. 1.
SCHOOL OF ENGINEERING.
President of the School: The Hon. Sir CHARLES PARSONS, O.M., K.C.B., M.A., LL.D., D.Sc., F.R.S., &c.
Head of the School: PHILIP KEMP, M.Sc. Tech., M.I.E.E., Assoc. A.I.E.E.
Head of Mechanical Engineering Dept.: E. F. THOMPSON, B.Sc., A.M.I.M.E.
The Day Department re-opens on September 17th, 1929. Entrance Examination commences 9th September, 1929, at 10 a.m.
Three-year DIPLOMA COURSES in
MECHANICAL ENGINEERING.
STRUCTURAL ENGINEERING.
ELECTRICAL ENGINEERING.
MOTOR CAR ENGINEERING.
Practice in the Laboratories, Drawing-office, Workshop and Field.
Fee 21 Guineas per annum.
There are three Entrance Scholarships in Structural Engineering.
The EVENING DEPARTMENT re-opens on September 23rd, 1929. Students enrolled from September 16th, 1929.
The Day and Evening Courses are recognised for the Diplomas and Certificates issued by the Institutions of Mechanical and Electrical Engineers in conjunction with the Board of Education.
Full prospectus free on application to the DIRECTOR of EDUCATION. 2914

PUBLIC NOTICES

University of Manchester.
PHYSICS DEPARTMENT.
Full particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR. The SESSION COMMENCES on THURSDAY, OCTOBER 3rd. 2832

The University of Sheffield.
SESSION 1929-30.
Vice-Chancellor: SIR HENRY HADOW, C.B.E., D.Mus., LL.D.
DEPARTMENTS OF MECHANICAL, ELECTRICAL, AND CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY, AND GLASS TECHNOLOGY.
The Courses in the above Departments extend over three or four years and prepare students to become specialists in one or other of these branches of Applied Science.
The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation and research.
Part-time Courses are arranged for students who desire to take special portions of any of the regular Courses.
In Mining Engineering and in certain of the Courses in Mechanical and Electrical Engineering, and in Glass Technology, arrangements are made to enable students who come to the University from works or collieries to take six months' Courses of study at the University and six months' practice at the works or colliery each year for a period of four years. During the first year such students should spend three terms at the University.
RESEARCH Fellowships and Scholarships are awarded annually.
The LECTURE COURSES commence OCTOBER 2nd, 1929.
The TECHNICAL LABORATORY COURSES commence SEPTEMBER 24th, 1929.
Particulars of Entrance and Research Scholarships available will be sent on application.
For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas, and Certificates awarded on their successful completion, application should be made to
W. M. GIBBONS, Registrar.
2923

PUBLIC NOTICES

County Borough of Croydon.
EDUCATION COMMITTEE.
TEACHERS are REQUIRED in the following subjects, for evening instruction (7.30-9.30), in the Mechanical Engineering Department of the Croydon Polytechnic, for Winter Session opening 23rd September, 1929 :—
1st Year Science Laboratory, Thursdays (Assistant Chemistry and Physics).
2nd Year Science Laboratory, Wednesdays (Assistant, Mechanics).
3rd Year Science Laboratory, Wednesdays (Mechanics and Heat).
4th Year Engineering Calculations, Wednesdays.
1st Year Machine Drawing, Fridays.
The fee varies from 12s. 6d. per evening of 2 hours for the lowest appointments to 18s. per evening of 2 hours for the highest, according to qualifications.
State fully, particulars of education, practical training, experience, present appointments, and age to the Principal, Central Polytechnic, Scarbrook-road, Croydon.
R. B. MORGAN, Education Officer.
Education Office, Katharine-street. 2915

Sunderland Education COMMITTEE.
SUNDERLAND TECHNICAL COLLEGE.
DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING.
APPLICATIONS are INVITED for the POST of full-time LECTURER in ENGINEERING. Candidates should possess an Honours Degree in Engineering, or its equivalent, and must have had works or drawing-office experience.
Salary in accordance with the Burnham Award.
Forms of application may be obtained from the Principal, the Technical College, and must be returned to the undersigned on or before Monday, 9th September, 1929, by first post.
HERBERT REED, Chief Education Officer.
Education Offices, 15, John-street, Sunderland, Co. Durham, 12th August, 1929. 2870

PATENTS AND DESIGNS ACTS, 1907 TO 1928.
Notice is Hereby Given that THE ROSE STREET FOUNDRY AND ENGINEERING COMPANY LIMITED, of 2, Rose-street, Inverness, and CECIL ALLARTON HADLEY, of 2, Rose-street, Inverness, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 190,734, granted to the said Cecil Allarton Hadley and A-I Manufacturing Company for an invention entitled "Improvements in Welding."
Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), of the 21st August, 1929.
Any person or persons may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
W. S. JARRATT, Comptroller-General.
2980

Bombay, Baroda and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Friday, 20th September, TENDERS for the SUPPLY of :—
GIRDER BRIDGES (39ft. and 39ft. 6in. clear span).
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG, Secretary.
Offices: The White Mansion, 91, Petty France, Westminster, S.W. 1, 27th August, 1929. 3022

NORTHERN INDIA
ENGINEERING DEVELOPMENT.
Many huge projects are completed, others are under construction, and still more are under consideration. When tendering, remember that we have handled, inter alia, all the material for the Lloyd Barrage, the largest irrigation scheme in the world, and that WE HAVE THE EXPERIENCE to enable us to quote you the most favourable terms for CLEARING and DESPATCHING up country any quantity of material to any site required.
For full particulars apply, EASTERN EXPRESS CO., Ltd., Karachi; or to Messrs. FORBES, FORBES, CAMPBELL and CO., Ltd. (Managing Agents), 9, King William-street, London, E.C. 4. P 5899

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For Advertisement Rates see Leader Page.

PUBLIC NOTICES

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for :—

18 SPANS PLATE GIRDER BRIDGES (60ft. span).

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Friday, 23rd August, 1929.

A fee of 20s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Tuesday, 3rd September, 1929.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board.

R. C. VOLKERS,
Secretary.

2967

City and County of Kingston-upon-Hull.

ELECTRICITY DEPARTMENT.

The Electricity Committee of the Hull Corporation invite TENDERS for the following CONTRACT, viz. :—

CONTRACT 144—STEEL RAILWAY BRIDGE, SIDINGS, &c.

Tender forms, general conditions and specification can be obtained upon application to the undersigned on payment of Two Pounds for each specification, which amount will be returnable on receipt of a bona fide Tender.

Additional copies may be had at a cost of One Pound each, not returnable.

Cheques and postal orders to be made payable to the City Treasurer, Guildhall, Hull.

The Corporation does not bind itself to accept the lowest or any Tender.

Tenders to be addressed to : "The Chairman, Electricity Committee, Town Clerk's Office, Guildhall, Hull," and endorsed "Contract 144," and must be delivered to the above address not later than NOON, Thursday, the 19th September, 1929.

J. N. WAITE, M.I.E.E., F.I.P.,
City Electrical Engineer.

Electricity Works,
Sculcoates-lane,
Hull,
August, 1929. 2986

Richmond Main Sewerage Board

The Board are prepared to receive TENDERS on behalf of the Joint Committee of the Middlesex and Surrey County Councils (Middlesex and Surrey Thames Bridges Act, 1928) for

DIVERSION OF A CERTAIN LENGTH OF THE BOARD'S MAIN SEWER IN THE PARISH OF MORTLAKE.

Specifications and drawings may be inspected at the Office of Mr. William Fairley, M. Inst. C.E., Parliament Mansions, Westminster, S.W. 1, or at the Main Drainage Works, West Hall-road, Kew Gardens, Surrey.

Copies of the quantities may be obtained on a deposit of a crossed cheque for £3 3s., made payable to the Board, which deposit will be returned on receipt of a bona fide Tender.

Sealed Tenders on forms provided must be received by the undersigned on or before 12 o'clock Noon 30th September, 1929.

Security for the due fulfilment of the contract will be required in accordance with Statute.

The lowest or any Tender may not be accepted.

WILLIAM MERRICK,
Clerk to the Board.

Bank Chambers,
39, George-street,
Richmond, Surrey. 2955

South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. 4-WHEELED STEEL BALLAST WAGONS (Metre Gauge, 72).
2. PRESSED STEEL SLEEPERS, &c.
3. COPPER RODS and TUBES and BRASS SHEETS, &c.
4. WATER CRANES.
5. HAND POWER RAM PUMPS.

MADRAS IMPROVEMENTS—ELECTRIFICATION OF SUBURBAN SERVICES.

6. CONVERTER EQUIPMENT for SUB-STATIONS.
7. TRANSFORMER SWITCHGEAR and ACCESSORIES.
8. OVERHEAD TRANSMISSION LINE.
9. CAR SHED STRUCTURAL STEEL WORK (1st Installation).

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for 4-Wheeled Steel Ballast Wagons," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Monday, the 7th October, 1929, in respect of Specification No. 1, and not later than Twelve Noon on Friday, the 13th September, 1929, in respect of Specifications Nos. 2 to 5, and not later than Twelve Noon on Friday, the 4th October, 1929, in respect of Specifications Nos. 6, 7 and 8, and not later than Twelve Noon on Friday, the 27th September, 1929, in respect of Specification No. 9.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specifications Nos. 1, 2, 6, 7 and 8, and of 10s. for each copy of Specification No. 9, and of 5s. for each copy of Specifications Nos. 3 and 4, and of 2s. 6d. for each copy of Specification No. 5.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, Westminster, S.W. 1,
28th August, 1929. 3021

River Wear Commissioners.

NO. 23 COAL STAITH SUPERSTRUCTURE.

The River Wear Commissioners are prepared to receive TENDERS for the MANUFACTURE and ERECTION of ONE or BOTH of the following :—

(A) A STEEL and TIMBER COAL LOADING STAITH, LAYING thereon of LINES of RAILWAY and the EXECUTION of other WORKS in connection therewith ;

(B) COAL HOPPERS, SHOOTS and an ELECTRICALLY DRIVEN COAL BELT CONVEYOR in the above Staith, upon land adjoining the Hudson Dock South, Sunderland.

The conditions of contract, forms of Tender, specification, schedules of quantities and drawings may be seen at the offices of the Commissioners upon application to the undersigned before the 14th day of September, 1929, or may be obtained until that date on payment of the sum of Ten Pounds (£10) by crossed cheque, which will be returned on receipt of a bona fide Tender accompanied by the whole of the documents.

Tenders, which will only be accepted on the forms supplied, must be completed in accordance with the detailed instructions incorporated in the documents, enclosed in a cover, sealed and endorsed "Tender for No. 23 Coal Staith Superstructure," and delivered to the undersigned at the Commissioners' Offices, Sunderland, not later than 10 a.m. on the 30th day of September, 1929.

The River Wear Commissioners reserve the right to reject a Tender without assigning a reason, and do not bind themselves to accept the lowest or any Tender.

F. HUMBLE,
Clerk to the Commissioners.

Harbour and Dock Offices,
St. Thomas-street, Sunderland,
30th August, 1929. 2997

YARROW HOME and HOSPITAL FOR CHILDREN BROADSTAIRS.

For the Early & Preventive Treatment of Disease & Convalescence after illness.

In these days of high cost of living, people of limited means are sometimes placed in a difficulty when their children are ill or need operations and afterwards require a change of air and much careful attention during convalescence. It cannot be too well known that the Yarrow Home and Hospital for Children, Broadstairs, Kent, was founded specially for the children of those who are not too well endowed with this world's goods. At this Home a child recovering from illness or an operation, or needing a long course of medical or surgical treatment, receives, amid the happiest possible surroundings and companionship, careful nursing and attention, such as could ordinarily only be obtained at expensive nursing homes. There are beds for fifty boys between the ages of four and twelve years, and for fifty girls between the ages of four and fourteen years. In special cases these age limits may be exceeded by two years. The fee is one guinea per week and travelling expenses. Applications for the entrance of patients are welcomed from professional people, such as members of the Institution of Civil Engineers, architects, artists, authors, clergymen, members of the medical, legal, and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the merchant navy, school masters, university professors, &c. The London office is at 116, Victoria-street, Westminster, and the Secretary will be pleased to send full particulars to anyone who is interested.

PUBLIC NOTICES

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF CAST IRON STRAIGHT PIPES AND SPECIALS.

The Metropolitan Water Board invite TENDERS for the SUPPLY of CAST IRON STRAIGHT PIPES and SPECIALS for the period ending 31st March, 1930.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer, on and after Monday, 26th August, 1929, by personal application at the offices of the Board (Room 156) or upon forwarding a stamped addressed sack envelope.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed "Tender for Cast Iron Pipes," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Wednesday, 18th September, 1929.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
13th August, 1929. 2920

Holborn Union, London.

Fully qualified ENGINEER REQUIRED at the City-road Institution, Shepherdess Walk, City-road, N. 1. Candidates must be competent to take charge of Steam Plant and Electric Light Installation, also Power Services, have had previous experience with Institution machinery, and possess Board of Trade Certificate. Salary £6 per week less deductions under the Superannuation and Insurance Acts. The appointment is subject to the Local Government Act, 1929. Forms of application may be obtained from the undersigned by forwarding a stamped addressed foolscap envelope, and must be returned to me duly completed on or before the 7th September, 1929.

CHAS. J. CROSS,
Clerk to the Guardians.

Administrative Offices,
53, Clerkenwell-road, E.C. 1,
26th August, 1929. 2994

Required for Important British-owned Railway in Argentina :—

STRUCTURAL STEEL WORK DRAUGHTSMAN, with thorough practical knowledge of Structural Details of all classes ;

GENERAL DRAUGHTSMAN, with thorough knowledge of Calculating and Design of Bridge Abutments and Retaining Walls, both in Brickwork and Armoured Concrete. Must have a sound knowledge of the design of Armoured Concrete Railway Structures and be capable of preparing working drawings and quantities.

Salary on 3 years' agreement £400, rising to £500 p.a. Free passages.

Write, stating which vacancy applied for, age, if single or married, education, training, and full details experience, with copies (only) of testimonials, to Box G.B.D., c/o Davies and Co., 95, Bishopsgate, London, E.C. 2. 3014

Surrey County Council.

HIGHWAYS AND BRIDGES DEPARTMENT.

APPLICATIONS are INVITED for the following APPOINTMENTS :—

ASSISTANT ENGINEERS (3), at salaries at the rate of from £8 to £10 per week, according to qualifications and experience.

JUNIOR ENGINEERING ASSISTANTS (4), at a salary at the rate of £3 10s. per week.

Applicants must have had experience in the Preparation of Plans, Specifications, and Quantities, and in Setting Out and Supervising the Execution of Road Works.

Preference will be given to candidates who are Associate Members of the Institution of Civil Engineers, and/or possess the Testamur of the Municipal and County Engineers.

The appointments will be to the Temporary Staff, and will not be subject to the Local Government Officers' Superannuation Act, 1922.

Applications, in candidates' own handwriting, stating age, experience, and qualifications, together with copies of recent testimonials, to be addressed to and must reach the County Engineer, Milner-road Annexe, Kingston-on-Thames, not later than Saturday, the 14th September, 1929.

DUDLEY AUKLAND,
Clerk of the County Council.

County Hall,
Kingston-on-Thames,
27th August, 1929. 3010

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a Good All-round ENGINEER, to assist in the General Management and Conducting the Outside Affairs of an established Welding Firm in Scotland. The successful applicant must be a real live wire of proved ability. A financial interest would be considered for the right applicant.—Write, stating age, wages expected, enclosing three copies of testimonials, to 3005, The Engineer Office. 3005 A

WANTED, ENGINEER, with Good Knowledge of Hydraulic Machinery and General Machine Shop Practice, for the commercial side of business. London district.—Address, stating age, experience, and salary expected, P6135, The Engineer Office. P6135 A

WANTED, For Canada, a BOILER SHOP SUPERINTENDENT. Must be thoroughly competent to Build and Repair Boilers of all descriptions, and to get work out of men. Sober and reliable, not over thirty years old.—Address, with references, to P6121, The Engineer Office. P6121 A

CIVIL ENGINEER, with Thorough Exper. of Road-making Material, including Bitumen, Tars, &c., WTD. for India. Com. sal., Rs. 750 p.m. Age 27/32, single. Excellent prospects.—Apply, LAURIE and CO., Employment Specialists, 28, Basinghall-st., E.C. No preliminary fee. 2960 A

SITUATIONS OPEN (continued)

COMMERCIAL MANAGER.—WELLINGTON TUBE WORKS DESIRE to APPOINT a FIRST-CLASS MAN, well educated and good personality, to Assist in Organising and Management of Sales. Excellent opportunity is presented and full particulars of experience, present position, age, &c., will be required.

Applications, which will be treated in confidence, will be received and considered up till September 12th, and should be addressed to the MANAGING DIRECTOR, Wellington Tube Works, Ltd., Great Bridge, Staffordshire. P6134 A

DIESEL ENGINEER of Good Social Standing, with practical and commercial experience, and capable of Supervising Erection and Running of Oil Engines, is WANTED for INDIA.—State full particulars as to experience and salary required, &c., to ATLAS DIESEL CO., Ltd., New Oxford House, Hart-street, London, W.C. 1. 2981 A

ELECTRICAL ENGINEER WTD., with First-class experience. Com. sal. £350 p.a. Age 25/30.—Apply, LAURIE and CO., Employment Specialists, 28, Basinghall-st., E.C. No preliminary fee. 2959 A

ENGINEER-SALESMAN for Leading Type of Stationary and Marine Diesel Engine. Age 28-35 ; running experience an advantage. State qualifications, experience and salary.—Address, 2992, The Engineer Office. 2992 A

EXPERIENCED ENGINEER REQUIRED By large General Engineering Firm (London District) to assist Chief Inspector. Must have had a wide experience on the inspection of high-class interchangeable parts to close limits and to pass Government inspectors, both during production and after assembly. Must also have been employed in a similar capacity.—Address, stating age, salary required and details of experience, in chronological order, to 2971, The Engineer Office. 2971 A

PLANNING (PRODUCTION) AND PROGRESS.—REQUIRED, HEAD of DEPARTMENT in Large Rubber Factory. Must have had previous experience. Progressive position.—Address, stating age, qualifications, and salary required, 3002, The Engineer Office. 3002 A

SALES-ENGINEER REQUIRED to Assist Sales Manager of large British firm of Air Compressor and Pneumatic Tool manufacturers. Young Engineer with actual selling experience, also accustomed estimating and dealing sales correspondence same products. —Address, 2985, The Engineer Office. 2985 A

TEA PLANTING.—An Important Tea Company has a VACANCY on its European Staff for a YOUNG GENTLEMAN (Public School boy preferred), aged 23-24, and unmarried, with ENGINEERING EXPERIENCE and preferably with a knowledge of CRUDE OIL ENGINES, to become a TEA PLANTER on its Estate in ASSAM. The position offered is, in the first instance, for a term of three years, from the date of arrival at the Estate, with salary for the first year at the rate of Rs. 250 a month (equivalent at Exchange of 1s. 6d. for the rupee to £225 per annum), rising by annual increments of Rs. 50 a month to Rs. 350 a month (£315 per annum) in the third year. Living quarters and medical attendance are provided free, and passage to the Estate is paid by the Company.—Applications should be addressed to Box "ASSAM," care of Davies and Co., 95, Bishopsgate, London, E.C. 2, and should give full particulars as to age, education and Engineering experience. 2983 A

TECHNICAL SALES MANAGER.—Prominent Firm specialising mainly in Ore and Rock Crushing Machinery will have VACANCY for sound, energetic, steady GENTLEMAN in above capacity. French, German, and possibly Spanish very desirable. Age over thirty. Salary upwards of £1000 p.a., according to qualifications.—Address applications in writing, stating age, qualifications, present occupation (in confidence), and salary expected, 2942, The Engineer Office. 2942 A

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£1500 to £2000 p.a., According to Experience, for COMMERCIAL ENGINEER to take complete charge Government contracts for an old-established firm. Work comprises tendering, sub-contracting where necessary, erection on site and handing over after test the equipment and plant manufactured. Only applicants having sound electrical and mechanical experience should apply ; preference will be given to those having Automatic Telephone experience.—Address in strict confidence, 2830, The Engineer Office. 2830 A

WANTED, a DRAUGHTSMAN, Experienced in Hydraulic Machinery, particularly Cranes and Hoists.—Apply by letter only, stating age, experience, and salary required, to the HYDRAULIC ENGINEERING CO., Ltd., Chester. 2911 A

DRAUGHTSMAN, Accustomed Mechanical Design A.C. and D.C. MACHINES. State age, experience and salary required.—Address, 2990, The Engineer Office. 2990 A

DRAUGHTSMAN, Age 23-30.—Write, with Particulars of education, salary expected, age, and full details of experience, applications will be treated in the strictest confidence, SECRETARY, Guest and Chrimes, Ltd., Rotherham. 2987 A

DRAUGHTSMAN, Good Senior, with Experience of large A.C. and D.C. Generators.—Address, stating qualifications, references, age, salary, and earliest date can commence, 2850, The Engineer Office. 2850 A

DRAUGHTSMAN, Junior Mechanical, REQUIRED by progressive firm in London. Exceptional opening for man capable of rising to position of trust. —Write, Box C876, Willings, 86, Strand, London, W.C. 2. 3016 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN REQUIRED for Design of Small Electrical Apparatus. Wireless experience an advantage. State age, experience and salary required. —Address, 2968, The Engineer Office. 2968 A

DRAUGHTSMAN REQUIRED IMMEDIATELY for London Consulting Engineers' Office.

Applicants must have had good workshop training in General Engineering and must be accustomed to Plant Layout and Foundation Work.

Address, stating age, training, experience, references, and salary required, P6133, The Engineer Office. P6133 A

DRAUGHTSMAN REQUIRED. Must be Experienced in General Steel Works Plant. State age, experience and salary required.—Address, 3004, The Engineer Office. 3004 A

DRAUGHTSMAN REQUIRED, with Rolling Stock and Tramcar experience ; London district. State age, salary and experience.—Address, 3007, The Engineer Office. 3007 A

DRAUGHTSMAN WANTED with Experience in Pumping Machinery and Auxiliary Plant.—Address, stating experience, age and salary required, to 2817, The Engineer Office. 2817 A

DRAUGHTSMAN, with Good Experience in Mechanical Design of Large D.C. Generators and Water-driven Alternators. Able to undertake responsibility for mechanical design and supervise work of assistants.—Address, stating experience, age, and salary expected, with copies of three references, 2803, The Engineer Office. 2803 A

DRAUGHTSMEN REQUIRED for Detailing Structural Steel Work, London office. Permanency for the right men.—Address, stating age, experience, and salary required, P6095, The Engineer Office. P6095 A

DRAUGHTSMAN, SENIOR, Having First-class experience of Electrical Control and Contactor Gear.—Address, stating age, experience, and salary required, together with copies of references, 3008 The Engineer Office. 3008 A

DRAUGHTSMAN, SENIOR, with Experience in Power Transformers.—Address, stating age, experience, and salary required, 3009, The Engineer Office. 3009 A

DRAUGHTSMEN.—TWO First-class MEN REQUIRED, used to detailing Steel-frame Buildings, Bridges, and General Constructional Work.—Apply, stating age, experience, and salary required, to BRAITHWAITE and CO., ENGINEERS, Ltd., West Bromwich. 2901 A

EXPERIENCED JIG and TOOL DRAUGHTSMAN REQUIRED, with experience in Tooling for Metal Aircraft, including Design of Dies for Draw Benches and Rolls Special Section Materials.—Address, stating age, experience, and salary required, 3001, The Engineer Office. 3001 A

FIRST-CLASS MECHANICAL DRAUGHTSMAN REQUIRED for London. Internal Combustion Engine experience and Fluent Russian essential. Salary, £350 p.a.—Applications, with particulars, experience, and copies of testimonials by letter, to "H. L.," c/o Charles Barker and Sons, Ltd., 31, Budge Row, E.C. 4. 2993 A

FIRST-CLASS RETORT SETTING DRAUGHTSMAN or DESIGNER, with good experience designing Vertical Retorts or Chambers, and Coke Oven Plant. Age about 35.—Write, stating age, experience, and salary required, to Z. A. 993, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 3018 A

GOOD MECHANICAL DRAUGHTSMAN REQUIRED for Vertical Retort and Coke Oven plant.—Write, stating age, experience and salary required, to Z. C. 995, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 3017 A

HEATING DRAUGHTSMAN, With Experience in the Design of up-to-date Systems of Hot Water and Steam-heating Apparatus.—Apply, stating age, experience, and salary required, to HOPE'S HEATING and LIGHTING, Ltd., Halford Works, Smethwick. 2983 A

JOHN HETHERINGTON and SONS, Limited, have VACANCIES for several MACHINE TOOL DRAUGHTSMEN. Applications are invited from men with good all-round experience of high-class Heavy Machine Tool work ; must be capable and efficient designers ; ability will be the first consideration. ANCOATS WORKS, MANCHESTER. 2840 A

JUNIOR JIG and TOOL DRAUGHTSMAN REQUIRED. State age, experience and salary required.—Address, 2969, The Engineer Office. 2969 A

JUNIOR DRAUGHTSMAN, Mechanical, Electrical, with general experience of Electrical Apparatus. State age, experience, and salary required.—Address, 2970, The Engineer Office. 2970 A

LEADING DRAUGHTSMAN for Steam Turbine Work. Must be capable of all detail designing from engineers' data ; only experienced senior men need apply.—Address applications in confidence, with copies of references, stating experience, salary required, age, 2894, The Engineer Office. 2894 A

MOTOR ROLLER or I.C. TRACTOR DRAUGHTSMAN REQUIRED. Must be capable designer with shop experience. Send full particulars, letter only in first place, age, technical education and full details of experience, with copies of references.—BARFORD and PERKINS, Ltd., Peterborough. 2998 A

REQUIRED AT ONCE, First-class DRAUGHTSMAN, sound Electrical and Mechanical Experience. Only men with initiative and original design experience need apply.—Write, in first instance, stating salary required and full details of experience, to CHIEF DRAUGHTSMAN, British Automatic Totalisator, Ltd., Plant House, Longfield-avenue, Ealing, W. 5. 3006 A

SENIOR DRAUGHTSMAN REQUIRED At Once, accustomed to designing structural steelwork, also JUNIOR DRAUGHTSMEN REQUIRED, accustomed to detailing.—Apply, stating age, experience and salary required, and when at liberty, to CHIEF DRAUGHTSMAN, Redpath, Brown and Co., Ltd., Trafford Park, Manchester. 3012 A

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STRUCTURAL DRAUGHTSMAN, Senior, WANTED for Glasgow district, accustomed to Detailing Steel Buildings. Quick and accurate worker, capability and efficiency are first considerations.—Apply in confidence, "CHIEF DRAUGHTSMAN," Redpath, Brown and Co., Ltd., Westburn Steel Works, Newton, Hallside, Lanarkshire. 3008 A

TOOL DESIGNERS, Competent Men with Press Tool experience preferred.—Write details of experience, &c., to EMPLOYMENT DEPT., Pressed Steel Co., Cowley, Oxford. 2890 A

For continuation of Small Advertisements see page 4.

A Seven-Day Journal

Noisy Aircraft.

THE problem of suppressing unnecessary noise in mechanically-propelled road vehicles is a difficult one to solve, both from the technical and the legislative points of view. Public appreciation of the fact that noise is not only an indication of inefficiency in the source emitting it, but also a potent cause of inefficiency and fatigue in all exposed to it is, however, growing. In that fact we perceive a more powerful force likely to operate for our relief than we can discover in the activities of the Home Office and the new powers given to the police. Another source of noise and disturbance now making itself evident in certain neighbourhoods is that produced by aeroplanes, and it is desirable that public attention should be turned to it before familiarity leads to its being accepted as inevitable. We are glad to learn that a sub-committee of the Aeronautical Research Committee has been appointed to discuss the question of aircraft noise, and are particularly pleased that the sub-committee will consider noise not only as it affects the amenities of air transport, but also as regards the disturbance which it causes to persons living in the neighbourhood of aerodromes. The problem set the sub-committee is a difficult one technically, for the noise given out by an aeroplane originates in a number of different sources, including the air screw, the engine exhaust, engine clatter, and the vibration of the stay wires and struts. The air screw is probably as great an offender in this respect as the engine exhaust. There is some evidence that the air screw tip speed has an important bearing on the question, and accordingly the sub-committee, it is intended, will carry out experiments on the noise emitted by air screws of different diameter but absorbing the same power and having widely different tip speeds. The reduction of the noise of the exhaust will also receive close attention, although it is much easier to silence an aero-engine on the test bed than in actual flight. The preparation of instruments to measure the noise of an aeroplane is to be undertaken by the National Physical Laboratory in co-operation with the Air Defence Experimental Establishment of the War Office, and with a member of the staff of the British Broadcasting Corporation.

The Timbers of the Empire.

ALTHOUGH our Empire possesses two million square miles of forest land producing an unexcelled variety of timbers, Great Britain draws nine-tenths of her requirements of wood from foreign countries. In order to promote the increased use of Empire timbers, the Empire Marketing Board and the Department of Scientific and Industrial Research have arranged to co-operate in a scheme for testing the qualities and uses of a large range of these timbers. Ultimately a complete catalogue of information on the subject will be made available as an outcome of the tests. To supervise the work to be undertaken an Empire Timber Committee is being set up, with Sir George Courthope, M.P., as chairman. The Forest Products Research Laboratory at Princes Risborough was established by the Department of Scientific and Industrial Research primarily to serve the wood-using industries of Great Britain. With the assistance of a capital grant not exceeding £30,000 from the Empire Marketing Board, the Laboratory is to be extended so as to be in an improved position to undertake extensive scientific and practical tests of Empire timbers at present comparatively unknown but likely to meet with a good reception on the British market. The new scheme also includes the organisation of efficient means of placing Empire timbers on the market and of encouraging their use in place of foreign grown timbers. Under this heading special arrangements are being made to secure the co-operation of the Dominion and Colonial Forest services in order that potential users may, in addition to having placed at their disposal a knowledge of the technical properties of the timbers, be kept informed concerning the availability of supplies and the cost at the port of delivery.

A Year's Railway Accidents.

THE Ministry of Transport on Tuesday published its annual report on accidents on the railways of Great Britain. The year 1928 was an unfortunate one for our railways, but despite that fact there was only one passenger killed for every 34·7 millions carried, while the number of passengers injured was one in 2·3 millions. The casualties to railway servants were at the rate of one killed per 27·8 million passenger and goods train miles worked, and one injured per 3·9 million. The total number of passenger casualties in train accidents as distinguished from accidents caused by the movement of trains and other railway vehicles, and accidents on railway premises, was 48 killed and 716 injured. All railway accidents being taken into consideration, 460 persons were killed and 24,324 injured. These figures are favourable to the railways when they are compared with road casualties. During 1928 the deaths arising from street accidents numbered 6138, and the number of persons injured 164,838. That last year was a bad one for the railways is shown by the fact that the number of passengers killed in train accidents was about four times as great as the average over the preceding eight years, and the number injured about twice the average. Forty-one out of the total of forty-eight passengers killed lost their lives in two accidents, those at Darlington and Charfield. The report emphasises the desirability for expedition and the carrying out of a more progressive policy in the matter of eliminating the use of gas on existing rolling stock. On the subject of the adoption of means for controlling the unlocking of carriage doors, it states that the liability of passengers meeting with an accident by falling out of carriages decreased in 1928 to one in 24,000,000, and holds that this figure does not justify the application of pressure on the companies to adopt a device for this purpose. As regards the public use of level crossings, the report states that taking into account the continued growth and altered character of road traffic, the broad conclusion is justified that the danger of such crossings to the public has not unduly increased.

London's Telephone Jubilee.

IN August, 1879, or exactly fifty years ago, the first telephone exchange was opened in London by the Telephone Company, Ltd., at 36, Coleman-street, E.C. The progress that has been made since 1879 can be gauged from the fact that whereas this early exchange had about half a dozen subscribers, the total number of subscribers in London at the present time is nearing 650,000. On May 31st of this year the number of subscribers in Great Britain was 1,775,870. At the time of the opening of the Coleman-street exchange several private lines were in existence, and one of the first is believed to have been installed at Chislehurst, where it served for communication between a private house and its stables. The switchboard erected at Coleman-street was imported from America, and consisted of two upright connecting boards, with two separate tables in front for the operators. At the end of the year 1879 two other London exchanges were opened, one at Leadenhall House and the other at 3, Palace-chambers, Westminster. In the following January there were about 200 subscribers connected to the company's system. Actually, the first telephone exchange in Great Britain was in Scotland, but, strictly speaking, it was not a public exchange. It was called the "Glasgow Medical Telephone Exchange," and, as the name implies, it was provided for the use of doctors, chemists, and hospitals. It was opened in March of 1879, and was quickly followed in Glasgow by "Legal," "Stockbrokers," and "Commercial" exchanges. At the outset all these exchanges were independent of one another, but ultimately means were provided for intercommunication. Manchester, Liverpool, and Edinburgh opened telephone exchanges in October, 1879, and in December of the same year Birmingham followed their example.

New Mail and Passenger Ships for the Western Highlands.

GOOD progress is being made with the building programme covering five vessels which has been undertaken by David MacBrayne (1928), Ltd., in accordance with the Highlands and Islands mail and passenger contract with the Post Office, already referred to in these columns. The first ship ordered was the twin-screw steamer "Lochness," which was built and engined by Harland and Wolff, Ltd., of Govan, Glasgow, and is now in service between Mallaig and Stornoway. The second vessel was launched from the yard of Henry Robb, Ltd., of Leith, on August 8th. She is a single-screw motor vessel for the Oban, Fort William, and Sound of Mull service, and will be propelled by Gardner engines. Similar propelling machinery of the twin-screw type, aggregating 600 S.H.P., is to be installed in the third and fourth ships, which have just been ordered from the Ardrossan Dockyard Company, Ltd. One of these ships will maintain the Oban and Outer Islands service, and the others will be placed on the Mallaig and Kyle of Lochalsh run to Tarbert and Harris. The order for the fifth vessel, which will be employed on the Oban, Staffa, and Iona service during the summer and the Glasgow–Ardrishaig service in the winter, has yet to be placed.

The Propelling Machinery of the Bremen.

ALTHOUGH the North German Lloyd Company has decided not to publish full technical particulars of the "Bremen" until about the middle of October, information is nevertheless gradually accumulating, both with regard to the hull and the propelling machinery of this high-speed liner. Speaking at a luncheon recently held in his honour in New York, Dr. Bauer, the designer of the propelling machinery, is reported to have given the full output of the machinery of the "Bremen" on trial as 130,000 S.H.P. It would be interesting to know whether this figure is for the turbines alone or whether it includes the auxiliary generator plant. Dr. Bauer also gave some interesting particulars with regard to the boiler plant. The ship, he said, had twenty water-tube boilers, eleven of which were double-ended and nine single-ended. These units are grouped in four separate boiler-rooms, and the tube heating surface of the boilers is about 161,460 square feet. Steam is generated at a working pressure of 327 lb. per square inch, with a total superheated steam temperature of 700 deg. Fah. The design of the boilers follows very closely that adopted in German naval work. There is a single upper steam drum of large diameter, with two smaller lower water drums and these drums are interconnected with curved tubes. In the space formed within the tube nests room is provided for the superheater elements. It may be noted that the average load equivalent for each water-tube boiler works out at 6500 S.H.P., which is a relatively high figure. The fuel consumption of the "Bremen" has been officially stated, we are given to understand, as 0·685 lb. of oil per S.H.P. hour for all purposes. This figure includes the main and auxiliary propelling machinery load, besides the loads for lighting, heating and all the hotel services.

Arbitration in the Cotton Trade Dispute.

LAST week we referred to the constitution of the arbitration board appointed to deal with the cotton trade dispute, and recorded that those mills which were in a position to do so had resumed operation at the wage rates in force before the dispute, pending the announcement of the Board's award. That award came with almost unexpected quickness. Evidence was heard in public on Wednesday and Thursday of last week, and on the afternoon of Thursday the chairman, Sir Rigby Swift, suggested that the two parties might get together and attempt to arrive at some suitable basis, for an agreement which might be acceptable to both sides. A joint conference was duly held, but without result, and later on Thursday evening the Board announced its decision. It upheld the case made out by the employers for a reduction of wages, but decided that the reduction should be 12·5 per cent. on the standard piece list rate of wages, as against the 25 per cent. demanded by the employers. This reduction is equivalent to a reduction of 6·41 per cent. on current wages, as against the 12·82 per cent. demanded by the employers. The Board also decided that an equal reduction should take place in the wages of all operatives who are not paid according to piece price lists. It is doubtful whether an industrial issue of such far-reaching importance has ever been decided more quickly by an arbitration board.

A Noteworthy Dutch Destroyer.

THE torpedo-boat destroyer "Van Galen," which has been built for the Royal Netherlands Navy by the Fijenoord Company, of Rotterdam, to the designs of Yarrow and Co., Ltd., of Scotstoun, Glasgow, has just completed a very successful series of trials on the Clyde. This vessel is the fifth of eight destroyers which are being constructed in Holland to the designs and under the technical advice of Messrs. Yarrow. In the first four destroyers which are already in service, a boiler pressure of 275 lb. per square inch, with a steam temperature of 610 deg. Fah., has been adopted. In the case of the "Van Galen," however, a boiler pressure of 400 lb. per square inch, with a steam temperature of 685 deg. Fah., is in use. and the same temperature and pressure will be worked to for the three remaining vessels which have yet to be built. We are able to state that the recent trials of the "Van Galen" which is distinguished as the highest pressure destroyer yet built, have fully borne out the advantages of high pressure and temperature which have been so well demonstrated in the recent passenger liners the "Viceroy of India" and the Canadian Pacific liners of the "Duchess" class, all of which ships are fitted with Yarrow water-tube boilers. It will be remembered that the British Admiralty has under construction a high-pressure destroyer the hull for which is being built by John I. Thornycroft and Co., Ltd., and the machinery supplied by the Parsons Marine Steam Turbine Co., Ltd.

Automatic Telephone Exchanges.

TWO additional automatic telephone exchanges are about to be opened to meet the rapid rate of development of the London telephone service. Both will be housed in a new steel and concrete six-storey building in Wood-street. At the outset they will deal with from 3500 to 4000 lines, and when the growth in the number of subscribers warrants further development, a third exchange will be provided in the same building. Developments now in progress will add to the London service new exchanges at intervals of a few weeks. Next month new automatic exchanges will be opened at Chelsea and Mitcham, whilst exchanges at North Finchley, Ilford, Hendon and Collindale are expected to be ready for service at the end of the year. When all these establishments are in operation there will be twenty-three automatic exchanges in the London area. The 642,400 London subscribers are at present served by 132 exchanges, but the growth of the number of subscribers at the rate of 4000 per month has necessitated the preparation of plans for expansion on a large scale, and thirty-one new exchanges are either projected or under consideration. Reckoning the population of Greater London at about seven million, the number of lines in the Metropolis is about equal to one per eleven people.

The Gatineau - Toronto Electric Transmission Line Terminal Station.

No. II.*

The Protective Relay Installation.

The wiring diagram of the Leaside station—see Fig. 3—has some unusual features, which are worthy of note.

(1) The station consists of a number of distinct elements, each connected to and separable from the other elements by the automatic oil circuit breakers. These elements fall into two classes :—

(*a*) Elements which lie entirely in this station, and which are called zones, are as follows :—

(i.) Four transformer zones, each consisting of one 45,000 kVA transformer bank with its power wiring as far as and including the oil circuit breakers

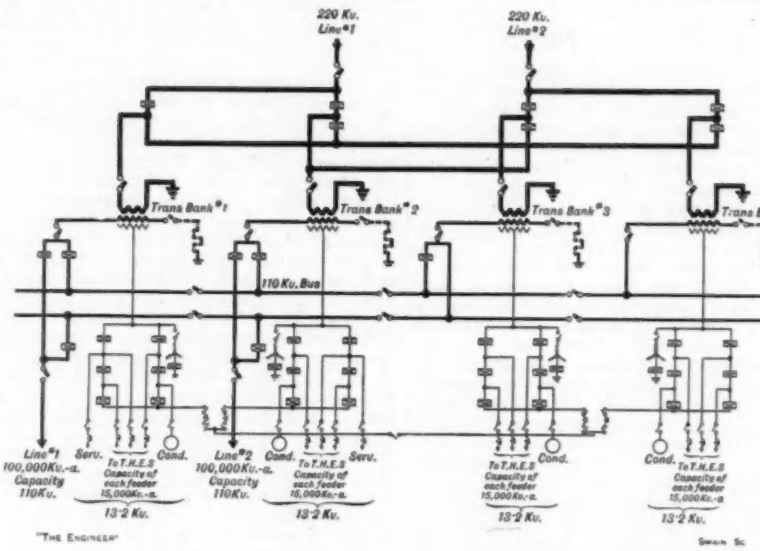

Fig. 3—Diagram of Main Connections at Leaside Transformer Station

in the various connections. The voltage rating of each transformer bank is : — High voltage : 194/204/214 kV star-connected with directly earthed neutral. Medium voltage : 112 kV, equipped for tap changing under load, with a range of ± 7½ per cent. in steps of 2½ per cent. each. The bank is star-connected with the neutral not earthed at present. Low voltage : 13·2 kV delta connected. This winding is earthed through a zigzag earthing reactor.

(ii.) Four condensers with supply cables and accessories, including the oil breakers. These condensers are intended to control the voltage automatically on the 13·2-kV system.

(iii). One 13·2-kV paralleling bus, with its necessary reactors and oil circuit breakers, which is intended to tie together the 13-kV banks and feeders. If load developments should require it, there may be two 110-kV buses.

(*b*) Lines or feeders interconnect this station with other stations, and, of course, only one end of each is at Leaside station. They are as follows :—

(i.) Two incoming 220-kV lines from Paugan.

(ii.) 110-kV lines to other Toronto stations, as required by load developments.

(iii.) 13·2-kV feeders of 15,000 kVA capacity each as required by load developments. At present there are four feeders to the Carlaw transformer station of the Toronto hydro-electric system.

(2) Each element has at least two connections through oil circuit breakers. On the high-voltage lines the limit at present is two, on account of the characteristics of the current transformers and relays.

(3) The elements are arranged in what amounts to a series of rings, as shown in Fig. 4. The 220-kV parts of the elements are arranged in a ring, the banks and lines alternating so far as possible. The 110-kV elements are arranged in a ring with lines and banks alternating. The 13-kV elements are grouped together into units which will correspond to one transformer bank. Each unit will consist of the 13-kV bank wiring, two or three feeders, one condenser and a connection to the paralleling bus, through a reactor, if that is found necessary to keep down short-circuit currents. These six elements are in a ring which may be supplied from the corresponding bank, or from other banks to the bus or from both. There are at present two units with two feeders each. The third feeder will be added or additional units constructed as the 13-kV load develops. This arrangement has been adopted to give a maximum of flexibility and security with a minimum number of breakers.

(4) On account of the small number of breakers, normal operation will be with all breakers closed. On the other hand, the arrangement permits any one breaker to be taken out of service without notice for inspection or maintenance, to test its operation, or keep it in good operating condition. This will facilitate proper maintenance and will overcome the tendency to fail to operate, which occurs when a breaker is left standing for months without operation.

(5) Each piece of equipment or line has a set of gang-operated disconnecting switches, by which it may be cleared from the ring if it is to remain out of service, thus allowing the breakers to be closed, completing the ring.

(6) The arrangement in separable elements permits any element to be disconnected from the system if a fault develops, without disturbing the rest of the system. It also lends itself to the application of relaying which will accomplish this.

(7) Each breaker belongs to two elements.

These same principles have been applied at the Paugan generating station and are being extended to important switching stations on the Niagara system, wherever it is advantageous to do so.

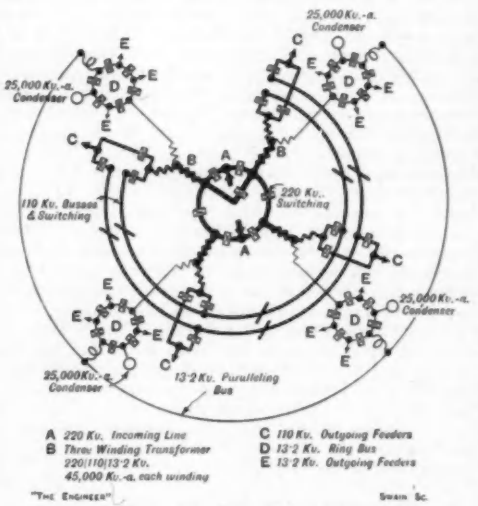
25,000 Kv.-a. Condenser
220 Kv. Switching
110 Kv. Busses & Switching
13·2 Kv. Paralleling Bus
A 220 Kv. Incoming Line
B Three Winding Transformer 220/110/13·2 Kv. 45,000 Kv.-a. each winding
C 110 Kv. Outgoing Feeders
D 13·2 Kv. Ring Bus
E 13·2 Kv. Outgoing Feeders
"The Engineer"
Swain Sc.

Fig. 4—Circle Diagram

General Requirements.

In the design of the protective relaying on this system, including that at the Toronto-Leaside transformer station, the following requirements were kept in mind :—

(1) The protection at the various stations must be so co-ordinated that all parts will operate in their proper relation to the whole system.

(2) It must be suitable to the operating requirements of the system and to the diagram of connections, and, conversely, the present possibilities of effective relaying should be one consideration in deciding upon the diagram.

(3) The purpose of the protective relaying is to promote continuity of service throughout the system by detaching therefrom any equipment or circuit which is creating a disturbance to the delivery of power owing to its faulty condition.

(4) In the station, the characteristics of relays, current transformers, cables, control circuits, and oil circuit breakers must all be taken into account and co-ordinated into a system which may be depended upon to give the desired results.

(5) The relay system should clear any faulty element without detaching any sound element. It must, under no circumstances, operate to give an interruption to service when there is no serious fault existing on the system.

(6) The protective relaying installed at Leaside to meet these requirements falls under three general classes, as follows :—

Complete Instantaneous Protection.—Complete instantaneous protection is provided to clear any phase-to-phase or phase-to-earth faults in the station or on the lines or feeders instantaneously, or at longest in 15

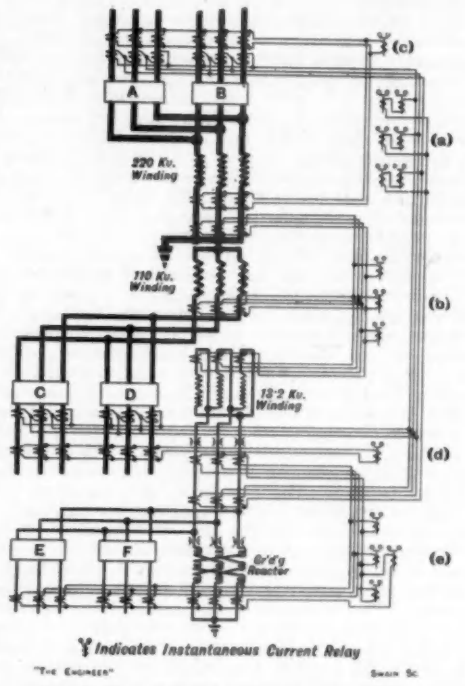

Fig. 5—Transformer Protective Gear Connections

cycles relay time. On the station "zones" the protection is of the differential type. In the case of long lines and feeders, the protection is of the directional distance type. Short lines are equipped with pilot wire protection. Each operates to isolate its own unit if defective. It is designed to operate properly with a minimum of one generator connected to the system at Queenston or two at Gatineau. Each zone protection, and to a large extent each line protection, has the additional desirable feature that it pays no attention to any faults outside its own well-defined area. When the relays are working properly and the breakers open when tripped, the faulty section will be isolated with practically no disturbance to the rest of the system. This will occur in every case if the relays and breakers are properly maintained.

Separating Standby Relays.—However, all equipment is fallible, and it is necessary to take account of contingencies. For that purpose standby distance or residual earth relays, which operate on the current through the banks which tie the sub-systems together, are used. These relays are timed to allow the instantaneous zone or line relays to clear if they will. They operate to separate the sub-systems, preferably in such a way that the generating capacity of each sub-system is approximately equal to the load, so that the sound sub-systems may carry on.

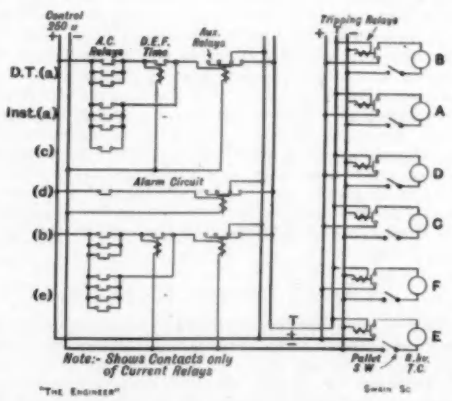

Fig. 6—Trip Circuit Diagram

Final Standby Relays.—There are also time-selective distance relays on the generator units which kill the defective sub-system after it has been separated from the sound ones.

Types of Relays Used.

In this particular system there are two requirements in the relays which are difficult to meet.

The amount of connected generator capacity and the number of lines and banks in parallel must

* No. I. appeared August 23rd.

vary from time to time, so that at times the fault current in a circuit may be less than the current it is carrying at other times under normal load conditions. This prevents the use, for phase-to-phase faults, of the directional inverse time excess current relay. Selectivity must be obtained by other means, and in this case it is obtained by confining the range of a relay to a zone by the differential connection, or to a length of line by the distance principle, or by selective timing. In either case the relays, being non-operative on load

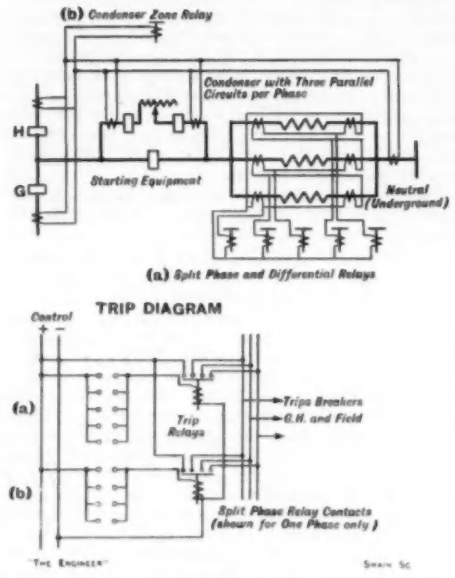

FIG. 7—CONDENSER ZONE WIRING DIAGRAM

current alone, may be set for currents lower than ordinary load value to take care of load condition.

On the Toronto-Leaside system relays of the following types have been used :—

(1) A plunger type current relay of a counterbalanced arm type instantaneous as to time, with a wide range of settings, and with very low impedance windings. These are used for zone differentials, earth residual currents, and similar purposes where such a relay is required.

(2) An instantaneous adjustable distance-range relay. Briefly, this relay takes cognisance of two phenomena which accompany a system fault, namely, increase in current and drop in voltage. When applied to a circuit, a solenoid at one end of a lever exerts a pull proportional to the line current, and is opposed by a solenoid on the other end, which exerts a pull proportional to the line voltage. The current coil tends to close the relay contacts. If the ratio volts to ampères at the relay is greater than a certain value at which the relay is set, the contacts remain open ; if not, the current overpowers the voltage and the contacts close. The ratio $\frac{E}{I}$ represents an impedance—the impedance of the line to a point which is the distance range of the relay. If the fault is nearer to the station than this point, the relay contacts close. If the fault is beyond the point, the relay contacts remain open. The relay is made selective, either by its setting range, so as not to

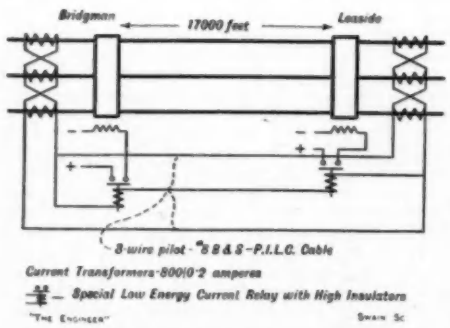
Bridgman
17000 feet
Leaside
8-wire pilot - 8 B & S - P.I.L.C. Cable
Current Transformers 800/0·2 amperes
Special Low Energy Current Relay with High Insulators
"THE ENGINEER"

FIG. 8—PILOT WIRE PROTECTION DIAGRAM

extend beyond the line on which it is used, or by timing.

(3) A plunger type excess-potential relay very similar to the current relay. This is chiefly used as an earth indicator.

(4) An adjustable definite-time auxiliary relay of accurate characteristics.

(5) A single-phase power directional relay which is very sensitive and quick acting.

(6) A multi-point control relay to handle the tripping current of breakers which is too great to be handled by the primary relays. The coil on this is operated from the control battery and takes very low current. The contacts may be grouped in any desired manner.

Each of these relays carries a mechanical semaphore as an operation indicator. The definite-time relay also indicates by a marker, in connection with the setting dial, how far the relay has travelled—that is, the time duration of the fault.

These indications on all the relays of the installation give information of great value in analysing fault conditions, in tracing trouble in the relay system itself, and give a very valuable perpetual check on the condition of the relay system.

TRANSFORMER ZONE RELAYS.

Current transformers of suitable ratio and characteristics are placed on each bushing of every circuit breaker of the zone, on the bushings external to the zone so as to include the breaker in the protected area. Each breaker is in this way included in two elements of the station, thus taking care of breaker failures, by clearing the zone on either side. The current transformer secondaries are connected differentially as shown in Fig. 5, so that if the kilovolt-ampèrage leaving the zone is equal to the kilovolt-ampèrage entering it, no matter through what breakers it goes, the secondary currents circulate without passing through any relays. A fault in the zone will create a difference between the kVA entering and leaving the zone, which will be represented by current in the relay circuits, and that can be made to trip circuit breakers.

This particular differential installation has the following interesting characteristics :—

(1) It includes circuits operating at three voltages, two of which are in star and one in delta connection. Moreover, on the 220-kV side, there are two 5 per cent. voltage taps, and on the 110-kV side there is a load tap changer which may be varied over a range of 15 per cent. voltage at will. In order to balance under normal conditions, equal kilovolt-ampères in each winding must be represented by equal secondary currents. For that reason the current transformers are wound with turns corresponding to the ampères at a given kilovolt-ampère rating in the respective primary winding. The 220-kV current transformers have taps which must be changed by hand when the bank taps are changed. The 110-kV current transformers have taps which are changed by drum switches which rotate with the power tap changer mechanism. The change from star to delta is suitably provided for in the current transformer connection.

(2) When a transformer bank, especially when it is operating at 25 cycles, is switched on to a live line, or when the voltage suddenly recovers to normal value after being at low value, as on the clearance of a short circuit, there is a rush of magnetising current to the bank which may be more than full-load current, but which quite rapidly drops to normal magnetising current. This rush of current into the zone is not balanced by any outgoing current, and its equivalent therefore appears in the differential relay circuit. It has to be reckoned with in the relay settings, which must be given timing at lower fault currents.

(3) There are six, and may later be eight, sets of current transformers in parallel on the zone breakers. Four at least of them are of the low-ratio bushing type with weak characteristics and high magnetising current requirements even at low secondary voltages. The relays, therefore, must have the lowest possible impedance.

(4) For the parts of the zone which do not include the bank itself the relays may and should be instantaneous. The engineers were unable to obtain an induction relay with suitable characteristics which could be given a minimum setting as low as desired and with anything like enough impedance for use with the number of current transformers. They used in

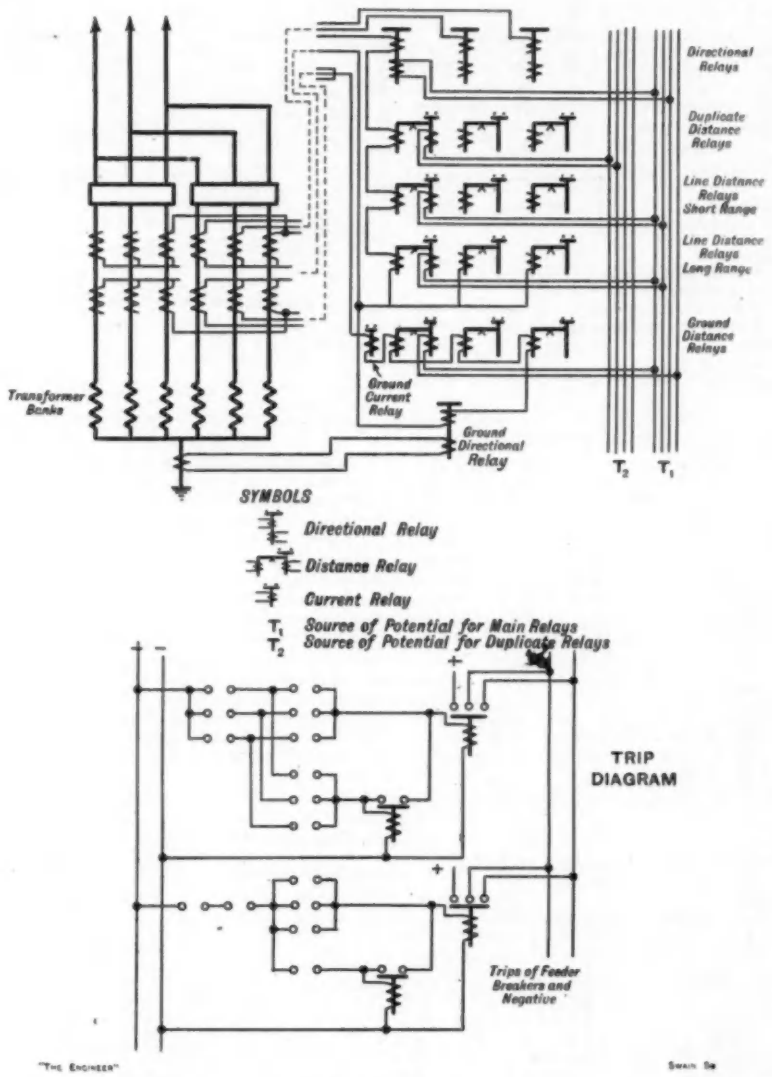

FIG. 9—LONG LINE PROTECTIVE GEAR CONNECTIONS

place of it the following combination of relays which gives the desired characteristics :—

(*a*) On the whole zone, for phase-to-phase faults, one set of instantaneous current relays set at about two or three times the bank rating. These relays will take care of external faults with moderately heavy generator capacity connected, and also of heavy internal faults. One set of relays timed about 0·6 to 0·8 second is set at about bank rating for medium faults. These relays will be operative down to minimum connected generator capacity, and will have fairly high current settings and consequent low impedance, so that the combination can be used with all the current transformers in parallel.

(*b*) On the bank itself, one current transformer on each winding with relays set at about 40 per cent. of bank rating at three seconds' time is used. The relays are of low impedance type, but of low current setting, so they have fairly high impedance. However, there are only three current transformers in parallel, so the combination is satisfactory.

The combination of (*a*) and (*b*) covers the bank itself with a protection with a stepped curve which is considered satisfactory.

(*c*) On the 220-kV wiring, a differential is arranged

The Gatineau - Toronto Electric Transmission Line Terminal Station.

No. II.*

The Protective Relay Installation.

The wiring diagram of the Leaside station—see Fig. 3—has some unusual features, which are worthy of note.

(1) The station consists of a number of distinct elements, each connected to and separable from the other elements by the automatic oil circuit breakers. These elements fall into two classes :—

(*a*) Elements which lie entirely in this station, and which are called zones, are as follows :—

(i.) Four transformer zones, each consisting of one 45,000 kVA transformer bank with its power wiring as far as and including the oil circuit breakers

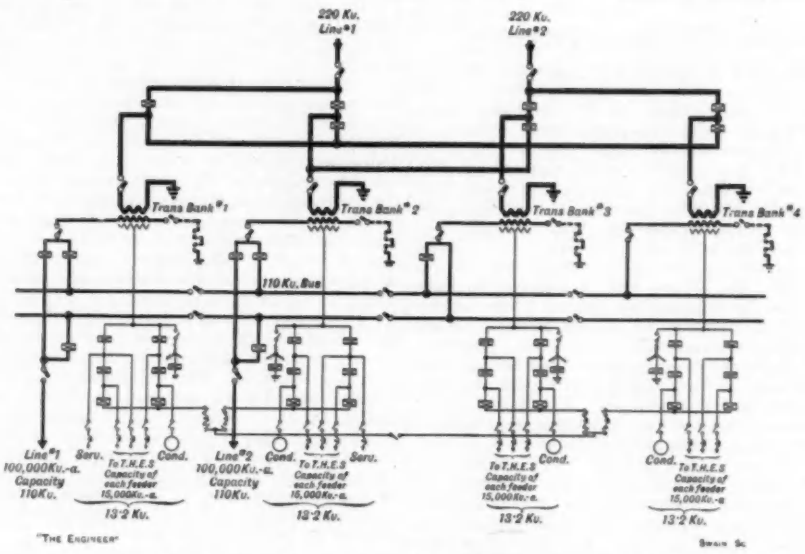

Fig. 3—Diagram of Main Connections at Leaside Transformer Station

in the various connections. The voltage rating of each transformer bank is : — High voltage : 194/204/214 kV star-connected with directly earthed neutral. Medium voltage : 112 kV, equipped for tap changing under load, with a range of ± 7½ per cent. in steps of 2½ per cent. each. The bank is star-connected with the neutral not earthed at present. Low voltage : 13·2 kV delta connected. This winding is earthed through a zigzag earthing reactor.

(ii.) Four condensers with supply cables and accessories, including the oil breakers. These condensers are intended to control the voltage automatically on the 13·2-kV system.

(iii). One 13·2-kV paralleling bus, with its necessary reactors and oil circuit breakers, which is intended to tie together the 13-kV banks and feeders. If load developments should require it, there may be two 110-kV buses.

(*b*) Lines or feeders interconnect this station with other stations, and, of course, only one end of each is at Leaside station. They are as follows :—

(i.) Two incoming 220-kV lines from Paugan.

(ii.) 110-kV lines to other Toronto stations, as required by load developments.

(iii.) 13·2-kV feeders of 15,000 kVA capacity each as required by load developments. At present there are four feeders to the Carlaw transformer station of the Toronto hydro-electric system.

(2) Each element has at least two connections through oil circuit breakers. On the high-voltage lines the limit at present is two, on account of the characteristics of the current transformers and relays.

(3) The elements are arranged in what amounts to a series of rings, as shown in Fig. 4. The 220-kV parts of the elements are arranged in a ring, the banks and lines alternating so far as possible. The 110-kV elements are arranged in a ring with lines and banks alternating. The 13-kV elements are grouped together into units which will correspond to one transformer bank. Each unit will consist of the 13-kV bank wiring, two or three feeders, one condenser and a connection to the paralleling bus, through a reactor, if that is found necessary to keep down short-circuit currents. These six elements are in a ring which may be supplied from the corresponding bank, or from other banks to the bus or from both. There are at present two units with two feeders each. The third feeder will be added or additional units constructed as the 13-kV load develops. This arrangement has been adopted to give a maximum of flexibility and security with a minimum number of breakers.

(4) On account of the small number of breakers, normal operation will be with all breakers closed. On the other hand, the arrangement permits any one breaker to be taken out of service without notice for inspection or maintenance, to test its operation, or keep it in good operating condition. This will facilitate proper maintenance and will overcome the tendency to fail to operate, which occurs when a breaker is left standing for months without operation.

(5) Each piece of equipment or line has a set of gang-operated disconnecting switches, by which it may be cleared from the ring if it is to remain out of service, thus allowing the breakers to be closed, completing the ring.

(6) The arrangement in separable elements permits any element to be disconnected from the system if a fault develops, without disturbing the rest of the system. It also lends itself to the application of relaying which will accomplish this.

(7) Each breaker belongs to two elements.

These same principles have been applied at the Paugan generating station and are being extended to important switching stations on the Niagara system, wherever it is advantageous to do so.

* No. I. appeared August 23rd.

General Requirements.

In the design of the protective relaying on this system, including that at the Toronto-Leaside transformer station, the following requirements were kept in mind :—

(1) The protection at the various stations must be so co-ordinated that all parts will operate in their proper relation to the whole system.

(2) It must be suitable to the operating requirements of the system and to the diagram of connections, and, conversely, the present possibilities of effective relaying should be one consideration in deciding upon the diagram.

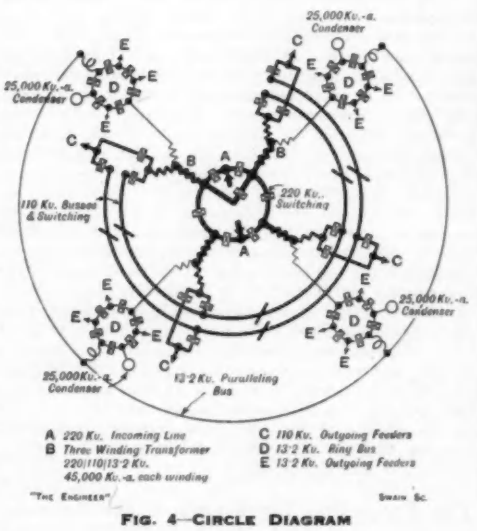
25,000Ku.-a. Condenser
110 Ku. Busses & Switching
220 Ku. Switching
13·2 Ku. Paralleling Bus
A 220 Ku. Incoming Line
B Three Winding Transformer 220/110/13·2 Ku. 45,000 Ku.-a. each winding
C 110 Ku. Outgoing Feeders
D 13·2 Ku. Ring Bus
E 13·2 Ku. Outgoing Feeders
"The Engineer"
Swain Sc.

Fig. 4—Circle Diagram

(3) The purpose of the protective relaying is to promote continuity of service throughout the system by detaching therefrom any equipment or circuit which is creating a disturbance to the delivery of power owing to its faulty condition.

(4) In the station, the characteristics of relays, current transformers, cables, control circuits, and oil circuit breakers must all be taken into account and co-ordinated into a system which may be depended upon to give the desired results.

(5) The relay system should clear any faulty element without detaching any sound element. It must, under no circumstances, operate to give an interruption to service when there is no serious fault existing on the system.

(6) The protective relaying installed at Leaside to meet these requirements falls under three general classes, as follows :—

Complete Instantaneous Protection.—Complete instantaneous protection is provided to clear any phase-to-phase or phase-to-earth faults in the station or on the lines or feeders instantaneously, or at longest in 15

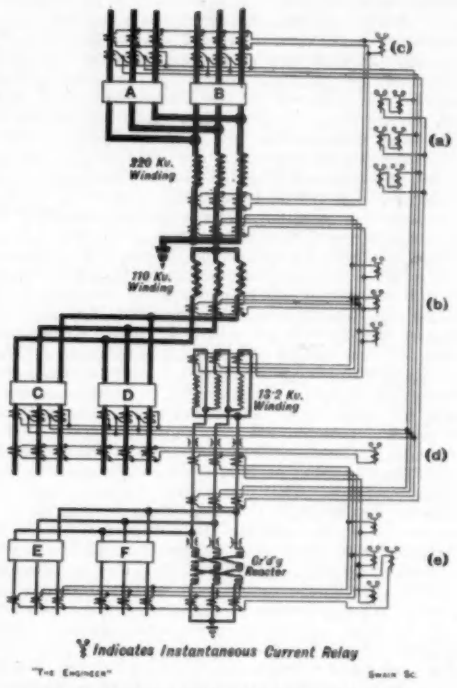

Fig. 5—Transformer Protective Gear Connections

cycles relay time. On the station "zones" the protection is of the differential type. In the case of long lines and feeders, the protection is of the directional distance type. Short lines are equipped with pilot wire protection. Each operates to isolate its own unit if defective. It is designed to operate properly with a minimum of one generator connected to the system at Queenston or two at Gatineau. Each zone protection, and to a large extent each line protection, has the additional desirable feature that it pays no attention to any faults outside its own well-defined area. When the relays are working properly and the breakers open when tripped, the faulty section will be isolated with practically no disturbance to the rest of the system. This will occur in every case if the relays and breakers are properly maintained.

Separating Standby Relays.—However, all equipment is fallible, and it is necessary to take account of contingencies. For that purpose standby distance or residual earth relays, which operate on the current through the banks which tie the sub-systems together, are used. These relays are timed to allow the instantaneous zone or line relays to clear if they will. They operate to separate the sub-systems, preferably in such a way that the generating capacity of each sub-system is approximately equal to the load, so that the sound sub-systems may carry on.

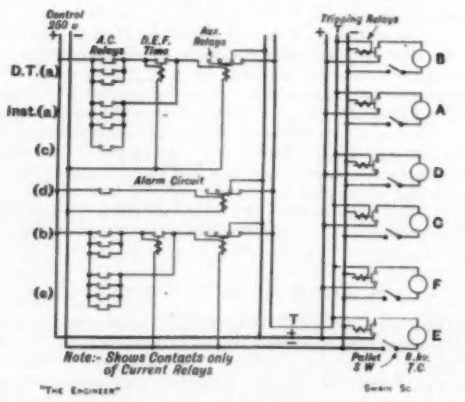

Fig. 6—Trip Circuit Diagram

Final Standby Relays.—There are also time-selective distance relays on the generator units which kill the defective sub-system after it has been separated from the sound ones.

Types of Relays Used.

In this particular system there are two requirements in the relays which are difficult to meet.

The amount of connected generator capacity and the number of lines and banks in parallel must

vary from time to time, so that at times the fault current in a circuit may be less than the current it is carrying at other times under normal load conditions. This prevents the use, for phase-to-phase faults, of the directional inverse time excess current relay. Selectivity must be obtained by other means, and in this case it is obtained by confining the range of a relay to a zone by the differential connection, or to a length of line by the distance principle, or by selective timing. In either case the relays, being non-operative on load

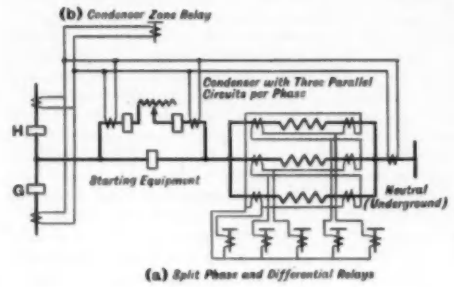

FIG. 7—CONDENSER ZONE WIRING DIAGRAM

current alone, may be set for currents lower than ordinary load value to take care of load condition.

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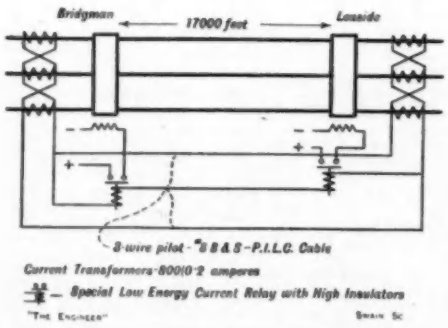
Bridgman
17000 feet
Leaside
3-wire pilot - "B B & S - P.I.L.C. Cable
Current Transformers-600/0·2 amperes
Special Low Energy Current Relay with High Insulators

FIG. 8—PILOT WIRE PROTECTION DIAGRAM

extend beyond the line on which it is used, or by timing.

(3) A plunger type excess-potential relay very similar to the current relay. This is chiefly used as an earth indicator.

(4) An adjustable definite-time auxiliary relay of accurate characteristics.

(5) A single-phase power directional relay which is very sensitive and quick acting.

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TRANSFORMER ZONE RELAYS.

Current transformers of suitable ratio and characteristics are placed on each bushing of every circuit breaker of the zone, on the bushings external to the zone so as to include the breaker in the protected area. Each breaker is in this way included in two elements of the station, thus taking care of breaker failures, by clearing the zone on either side. The current transformer secondaries are connected differentially as shown in Fig. 5, so that if the kilovolt-ampèrage leaving the zone is equal to the kilovolt-ampèrage entering it, no matter through what breakers it goes, the secondary currents circulate without passing through any relays. A fault in the zone will create a difference between the kVA entering and leaving the zone, which will be represented by current in the relay circuits, and that can be made to trip circuit breakers.

This particular differential installation has the following interesting characteristics :—

(1) It includes circuits operating at three voltages, two of which are in star and one in delta connection. Moreover, on the 220-kV side, there are two 5 per cent. voltage taps, and on the 110-kV side there is a load tap changer which may be varied over a range of 15 per cent. voltage at will. In order to balance under normal conditions, equal kilovolt-ampères in each winding must be represented by equal secondary currents. For that reason the current transformers are wound with turns corresponding to the ampères at a given kilovolt-ampère rating in the respective primary winding. The 220-kV current transformers have taps which must be changed by hand when the bank taps are changed. The 110-kV current transformers have taps which are changed by drum switches which rotate with the power tap changer mechanism. The change from star to delta is suitably provided for in the current transformer connection.

(2) When a transformer bank, especially when it is operating at 25 cycles, is switched on to a live line, or when the voltage suddenly recovers to normal value after being at low value, as on the clearance of a short circuit, there is a rush of magnetising current to the bank which may be more than full-load current, but which quite rapidly drops to normal magnetising current. This rush of current into the zone is not balanced by any outgoing current, and its equivalent therefore appears in the differential relay circuit. It has to be reckoned with in the relay settings, which must be given timing at lower fault currents.

(3) There are six, and may later be eight, sets of current transformers in parallel on the zone breakers. Four at least of them are of the low-ratio bushing type with weak characteristics and high magnetising current requirements even at low secondary voltages. The relays, therefore, must have the lowest possible impedance.

(4) For the parts of the zone which do not include the bank itself the relays may and should be instantaneous. The engineers were unable to obtain an induction relay with suitable characteristics which could be given a minimum setting as low as desired and with anything like enough impedance for use with the number of current transformers. They used in

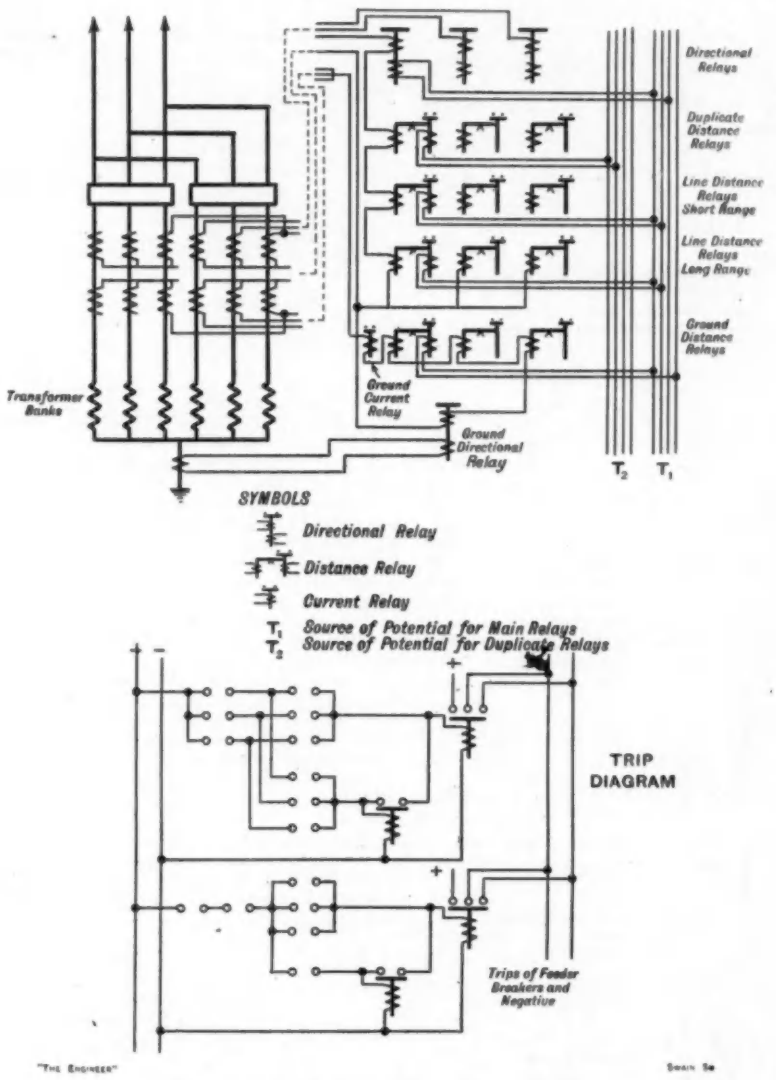


FIG. 9—LONG LINE PROTECTIVE GEAR CONNECTIONS

place of it the following combination of relays which gives the desired characteristics :—

(*a*) On the whole zone, for phase-to-phase faults, one set of instantaneous current relays set at about two or three times the bank rating. These relays will take care of external faults with moderately heavy generator capacity connected, and also of heavy internal faults. One set of relays timed about 0·6 to 0·8 second is set at about bank rating for medium faults. These relays will be operative down to minimum connected generator capacity, and will have fairly high current settings and consequent low impedance, so that the combination can be used with all the current transformers in parallel.

(*b*) On the bank itself, one current transformer on each winding with relays set at about 40 per cent. of bank rating at three seconds' time is used. The relays are of low impedance type, but of low current setting, so they have fairly high impedance. However, there are only three current transformers in parallel, so the combination is satisfactory.

The combination of (*a*) and (*b*) covers the bank itself with a protection with a stepped curve which is considered satisfactory.

(*c*) On the 220-kV wiring, a differential is arranged

from the breakers to the transformer neutral with one instantaneous relay to take care of earths on the 220-kV station connections.

(*d*) An instantaneous differential for earths on the 110-kV part of the zone similar to (*c*).

(*e*) An instantaneous differential for phase-to-phase faults, as well as earths on the 13-kV part of the zone. This has to take care of the 13-kV earthing reactor.

These relay groups trip a master relay, which in turn operates tripping relays so that all of the six or eight zone breakers are tripped simultaneously. The

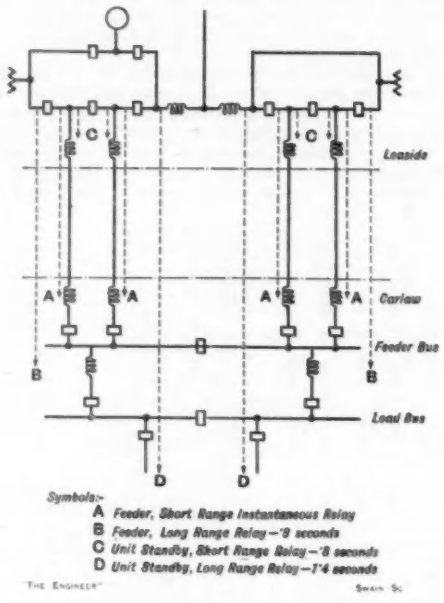


FIG. 10—FEEDER DIAGRAM

connections are shown in Fig. 6. The master relay also carries extra contacts for operating an alarm.

CONDENSER ZONE.

The details of the condenser zone will be along the following general lines :—

The condenser neutral will not be earthed, as each 13-kV unit will be earthed through a zig-zag reactor connected to the transformer bank. A differential will be installed to cover the whole zone from the two 13-kV ring breakers to the condenser neutral for phase faults and earth faults. In this, provision will have to be made to take care of the use of the auto-transformer in starting. This protection will be instantaneous, using current relays and current transformers outside the zone on the ring breakers and on the condenser neutral. A diagram showing the proposed wiring is given in Fig. 7.

There will also be a split phase protection on the condenser windings. Each phase is wound in three parallel circuits, which will be balanced against each other to detect turn-to-turn faults in the winding. This will be combined with a differential on the winding itself to allow a fully effective setting for any earth further than one coil from neutral.

The relays are all instantaneous, and trip the condenser ring breakers and the field breaker. The starting equipment for the condenser is of the automatic push-button-controlled type, so that bearing temperature relays, winding temperature relays, reverse phase and other features will be required.

110-kV LINES : PILOT WIRE PROTECTION.

Each of the 110-kV lines to Bridgeman transformer station is equipped with pilot wire protection—see Fig. 8—which is really a form of zone differential protection. The lines protected are on double-circuit towers, the conductors of each circuit being arranged vertically and with no transpositions. Owing to the facts that a very low current setting was required in order to operate satisfactorily with only one unit on the system at Queenston, and that the breakers and bushing current transformers were of three different designs and dimensions, it was necessary, in order to minimise the tendency to unbalance, to design special current transformers of 800/0·2 ampères ratio with 4000 secondary turns, and also to design special low-impedance, highly insulated relays. The pilot, which is a three-conductor, paper-insulated, lead-covered cable, runs parallel with the transmission line in a duct line, and is subject to electro-magnetic induction of some magnitude. Ordinary protectors, which operate by drawing off voltage to earth, cannot be used, as they would prevent the system from operating when it is most needed. It was therefore decided to operate with the pilot relay system entirely insulated from earth. This system opens up the breakers on a defective line simultaneously at both ends

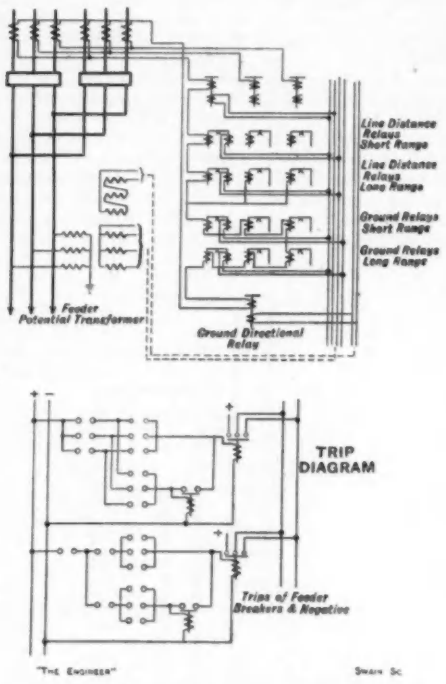


FIG. 13—FEEDER PROTECTION CONNECTIONS

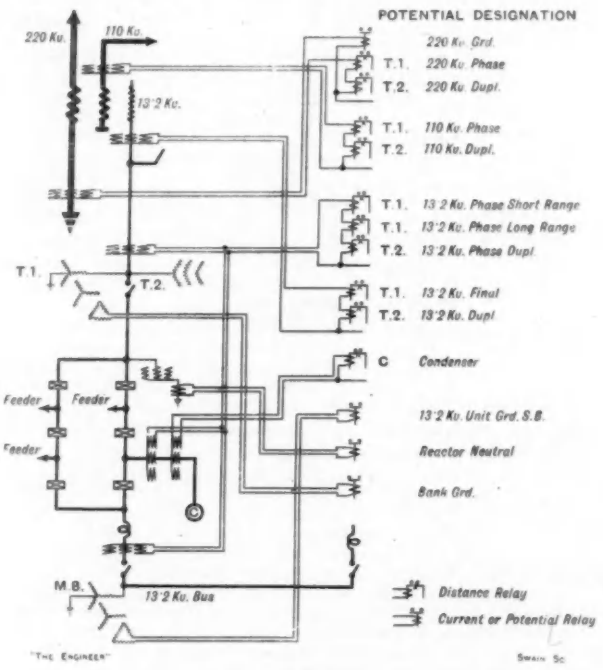


FIG. 11—STANDBY RELAY DIAGRAM

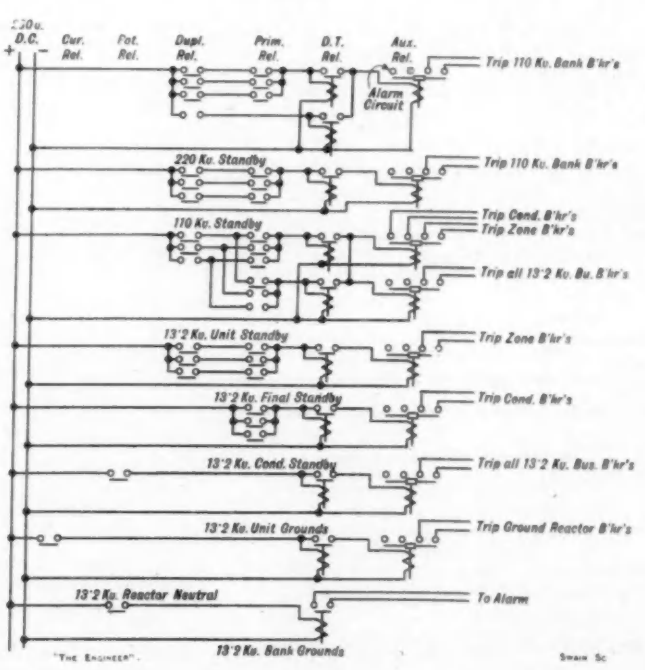


FIG. 12—STANDBY PROTECTION TRIP CIRCUIT DIAGRAM

very quickly for fault currents as low as 150 ampères.

220-kV LINE.

At present there is only one 220-kV line, but later there will be two and possibly more. Each line will be equipped at either end with the best protection possible for single radial line operation. When two or more lines are in service it will be supplemented by a parallel line protection of the standard current balance type, for phase faults and earth faults.

Radial Line Protection.—The radial line protection is designed to clear instantly, at one end at least, any phase-to-phase or phase-to-earth fault on the system. It is also selective with the station zone protections, so as not to give interruption for a station zone fault. It is considered that while phase-to-earth faults are more common, provision must be made for simultaneous earths on two phases, or phase-wire-to-phase-wire faults in a country in which lightning and sleet are liable to be severe.

This phase-to-phase protection consists of directional double range distance relaying, as shown in the diagram, Fig. 9, and comprises :

(*a*) One set of directional elements, required to make the instantaneous line relays direction-selective with the Leaside bus protection.

(*b*) One set of instantaneous distance relays set with a three-phase distance range just short of the Paugan bus. These will be effective over about 75 to 80 per cent. of the line to Paugan and doubtful or slow of the remainder of the distance. They will positively not be affected by Paugan station faults or beyond. Paugan instantaneous relays are similarly set with regard to the Leaside bus.

(*c*) One set of distance relays timed 0·6 to 0·8 second to be time-selective with the Paugan station relays, and with a distance range to be completely effective under all conditions to the end of the line.

(*d*) A duplicate set of distance elements only, with the same setting as (*c*), but using a separate source of potential. These relays are required on account of the small number of lines and the current setting of the relays below normal load value.

Ground Protection.—Relays for earth protection all use earth residual current from the neutral wire of the current transformer group. They comprise :—

(*a*) An earth directional relay using transformer neutral current as a direction reference current.

(*b*) A residual current relay. The trip current from this apparatus supplies the distance elements (*c*) and also a definite time relay timed at 0·8 seconds to be time selective with Leaside or Paugan station earth relays.

(*c*) A set of instantaneous earth distance relays, using voltages from the respective phases to earth. The range of these relays is to be definitely short of the Paugan bus. Owing to inherent variations in phase-to-earth impedance, these instruments can probably not be made effective for over 50 to 60 per cent. of the whole length of the line. To that extent they are somewhat experimental, and their operation is being closely watched and analysed. The earth relays are of specially small, very low impedance type.

The current-balance protection on parallel lines when such is available, will speed up the clearances somewhat on earth faults, but it is believed the radial line protection in itself will give very satisfactory results. The combination will be selective by timing and direction with the zone protections at either

end, and by distance range and direction with the 110-kV systems. It will clear all phase-to-phase or earth faults at one end instantly, and at both ends instantly over the whole line, except for about 20 per cent. of its length at the end remote from the respective stations, in which case the timing of the relays is about 0·6 to 0·8 second. The total relay, auxiliary and breaker opening time on a line fault was found in one case to be 14 to 15 cycles.

13-kV Feeders.

The protection on the 13-kV feeders is of the directional, double-distance range type, without duplicate feature, as the setting is above the capacity of the cables, which are three 1,000,000 cir. mils. single conductor, paper-insulated, lead-covered per feeder, with a maximum feeder rating of about 15,000 kVA. In each feeder there are two current-limiting reactances, one at each end, of 2½ per cent. on 15,000 kVA. Between the Carlaw receiving bus and the load bus there is another reactor. This system of reactors furnishes very convenient barriers to the range of phase and earth distance relays, so that the Leaside instantaneous relays can be made fully effective to the Carlaw reactors, but will not be affected by faults beyond that point.

The Toronto Hydro-Electric System end of the feeders is equipped with directional current phase and ground relays set to operate practically instantaneously for feeder faults. The combination at the two ends assures clearance of any cable fault as fast as breakers can open. Fig. 10 is a diagram of the feeders from two units showing the reactor arrangement and distance ranges of relays. The diagram of connections shown in Fig. 13 is very similar in general principles to that on the 220 kV line, except that the double range is used for earths as well as phase faults. This is allowable, as the cable system gives a definite impedance for earth currents, whereas on open lines this impedance volume is less certain.

Station Buses.

The 13-kV paralleling bus and the 110-kV buses will each be protected by an instantaneous differential current relay system supplied form current transformers on the remote side of each bus breaker, and operating on phase-to-phase or phase-to-earth faults. The relays will trip all breakers feeding their respective buses.

Standby Relays.

These relays are provided to deal with the situation arising in case the instantaneous relays have failed to operate completely, so that the fault is still on the system after a second or so. In such a case, some inconvenience and loss of service may be expected, but an endeavour has been made to confine this trouble to as narrow limits as possible by separating out the defective sub-system so that the sound subsystem can return to normal as quickly as possible. Fig. 11 shows the various standby protections and Fig. 12 the tripping diagrams. The standby system is complicated by the fact that power may be taken from the station from any one or two of three windings.

A New Transpyrenean Railway.

In our issue of August 3rd, 1928, we published an account of the transpyrenean railway between Bedous in France and Jaca in Spain, which had been formally put into service on July 18th previous in the presence of the King of Spain and President Doumerge. That line, which crossed the Franco-Spanish frontier in the Somport tunnel, was the first of the three transpyrenean railways which it was agreed, by an International Convention—signed by Monsieur Delcassé and Sen. F. de Léon y Castillo in August, 1904, and modified by an additional protocol dated April 15th, 1908—should be constructed between France and Spain. The two other lines agreed upon were (*a*) that between Ax-les-Thermes, in the Department of Ariège, which was to pass in tunnel under the Col de Puymorens, cut the frontier near Puigcerda, pass in tunnel under the Col de Tosas, and make junction at Ripoll with the line from Granollers to San Juan de las Abadesas · and (*b*) that between Saint Girons, also in the Department of Ariège, which was to pass up the valley of the Salat, proceed in tunnel under the Col de Salau, and enter Spain by the valley of the Noguera-Pallaresa.

The Ax-les-Thermes line—the second to be completed—was opened for service on July 21st last, and it provides direct communication between Toulouse and Barcelona, whereas hitherto it has been necessary to proceed by way of Narbonne and Perpignau in order to get from the one place to the other. In its issue of August 3rd our contemporary *Le Génie Civil* published an iilustrated description of the new line, and the particulars contained in what follows are derived from that source.

The new line closely resembles in its general nature the Bedous–Jaca railway, though it mounts to a higher elevation. On leaving Ax-les-Thermes, which stands at an altitude of 701·36 m.—say, 2300ft.—it begins to climb at once, and passing by Mérens it reaches the village of l'Hospitalet at an elevation of 1428 m. Just beyond that point it enters the Puymorens tunnel—the longest on the line—which is 5355 m. long, and in which an elevation of 1567·25 m. is attained. Beyond the tunnel the line descends by way of Porta and arrives at the French international station, Latour-de-Carol, which is just on the French side of the frontier and which stands at an elevation of 1231·5 m., or, say, 4040ft.—only some 350ft. lower than the summit of Ben Nevis, the highest point in the British Isles. By reason of the disposition of the frontier in this locality, the line crosses the main chain of the Pyrenees under the Col de Puymorens entirely in French territory, whereas one end of the

RAILWAYS IN FRANCE AND SPAIN

Somport tunnel on the Bedous–Jaca line, is in France and the other end in Spain.

The stations passed on leaving Ax-les-Thermes are Mérens (1057 m.), l'Hospitalet (1428 m.), both in the Department of the Ariège; Porté Halt (1562·7 m.), Porta (1506·5 m.), and Latour-de-Carol, in the Department of the Pyrénées-Orientales. At this point connection is made with the electrified metre-gauge line Villefranche-Vernet-les Bains to Latour-de-Carol, which is a prolongation of the standard gauge line in the valley of La Têt from Perpignan to Villefranche–Vernet-les-Bains. Just beyond Latour-de-Carol the line crosses the frontier and arrives at the Spanish International Station at Puigcerda, where junction is made with the Spanish line running to Ripoll and thence to Barcelona.

A plan and a profile of the French portion of the line are given in the engravings on the next page. As a matter of interest, the profile onwards to Ripoll is also given. The length of the line from Ax-les-Thermes to Latour-de-Carol is 39·7 kiloms.; from there to the frontier is 1686 m.; while Puigcerda is 3850 m. further on. The total distance between Ax-le-Thermes and Puigcerda is, therefore, 45·236 kiloms., or rather over 28 miles. The maximum gradients are of the order of 40 mm. per metre—or 1 in 25—and the minimum radius of the curves is 200 m.—or 656ft.

As might have been anticipated in view of the nature of the country passed through, the making of the line has necessitated the piercing of numerous tunnels, the construction of many bridges and viaducts, and much rock cutting in hill sides. Between Ax-les-Thermes and l'Hospitalet—a distance of some 21 kiloms.—there are ten tunnels, of which the most important are the Couloubret (630 m.), the Berduquet (522·75 m.), the spiral tunnel at Saillens (1750 m.), and that at Barthe-Espesse (1224 m.). Finally, there is the long Puymorens tunnel, which has an up gradient of 1 in 30 on the Ariège side and a down gradient of 1 in 333 on the Pyrénées-Orientales side. The bridges, which are all, save one, of masonry, are necessary for crossing the Rivers Oriège, Nabre, Ariège, and Carol, as well as many smaller streams and gorges. Some of the bridges, as, for instance, that crossing the Carol, which is shown in our half-tone engraving, are very handsome structures. All the works in French territory were designed by French Government engineers, and nearly all of them were carried out by La Société des Grandes Entreprises Méridionales.

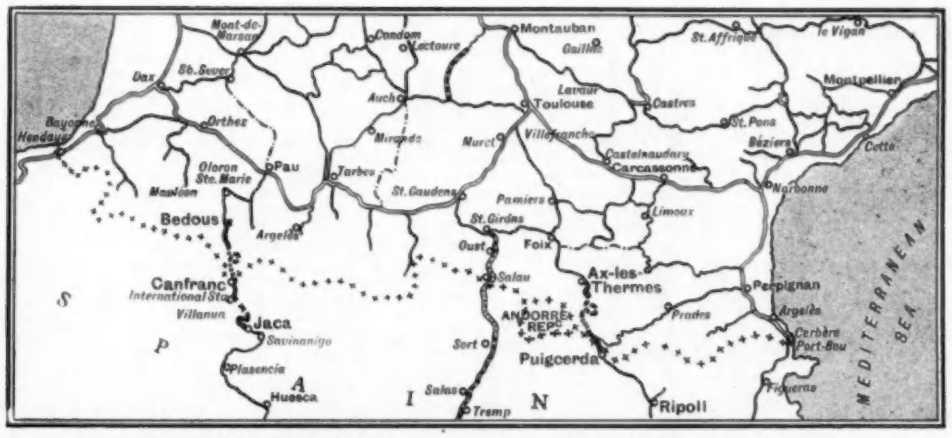
Beyond Puigcerda the line runs, as has been said, to Ripoll, which is on the line from Barcelona to San Juan de las Abadesas. The construction of this line was begun in 1911, and as it was not hindered by the war, which stopped the works in France, it was possible to put the section between Ripoll and Ribas—a length of 14 kiloms.—into service in 1919. In 1922 the whole line was opened, steam locomotives being used to operate it.

The Spanish portion of the new line from Puigcerda to Ripoll is about 50 kiloms. in length and it comprises two main tunnels, the first being that under the Col de Tosas, where the line reaches an altitude of 1494·2 m., or only 73 m. lower than the highest point on the French side of the frontier. The line as a whole, therefore, has the peculiarity that it embodies two tunnels driven successively through two parallel ranges of mountains. It crosses the frontier at an elevation of 1200 m., descends to 1100 m., where the Sègre is crossed, and then mounts with gradients of 2·7, 3·9, and 4·1 per cent. up to the Col de Tosas tunnel, which has a length of 3840 m. Beyond the tunnel the line descends with gradients varying from 3·8 to 1·12 per cent. up to Ripoll. The stations passed after Puigcerda are Caixans, Alp, la Molina, Tosas, Planolas Ribas, Baños de Ribas, Campdevanol, and Ripoll.

The other tunnel, which is spiral and 1021 m. long, comes between Tosas and Planolas. It is on a gradient of 3·5 per cent. for the whole of its length, so that, in the tunnel, the line descends through a vertical height of some 107ft. There are other tunnels on the line, but none is of any great importance, all being shorter and none having involved any serious difficulty. Of bridges those across the Rio Rigart and the Rio Fresser are the most noteworthy. The former is a skew bridge built on a curve in plan. It has a principal steel span of 46 m. and three other openings each of 9 m. The Rio Fresser Bridge has two principal masonry arches, each of 24 m. opening.

In the driving of the Tosas tunnel a good deal of trouble was experienced. The ground traversed, which belongs to the Lower Silurian, was found to be very heterogeneous in character. It contained, for example, veins of quartz and disintegrated rock of poor consistency. It was originally intended to use a lining 0·6 m. thick, but it was found necessary during the work to increase that thickness to 1·5 m. at the crown and to from 2 m. to 2·5 m. at the haunches. The soil—for, apparently, it might well be given that name—was in places so inconsistent and friable that it forced its way through shuttering, and, sometimes, because it swelled, it prevented the concrete from setting properly. These difficulties had the effect of causing such irregularities in the lining that at one time the desirability of abandoning the workings and attempting, by altering the alignment of the tunnel, to find better ground was seriously considered. However, it was eventually decided to continue to proceed on the original line, but to increase the thickness of the lining to 3 m.—or very nearly 10ft. The advance heading itself had even to be given a lining of 0·8 m.

The line between Ax-les-Thermes and Puigcerda is equipped, as are the other electrified lines of the Midi Company's system, for operation at 1500 volts direct current and catenary overhead wire transmission. The energy to operate the line is obtained from the Railway Company's generating stations in the Central and Western Pyrenees, whence it is con-

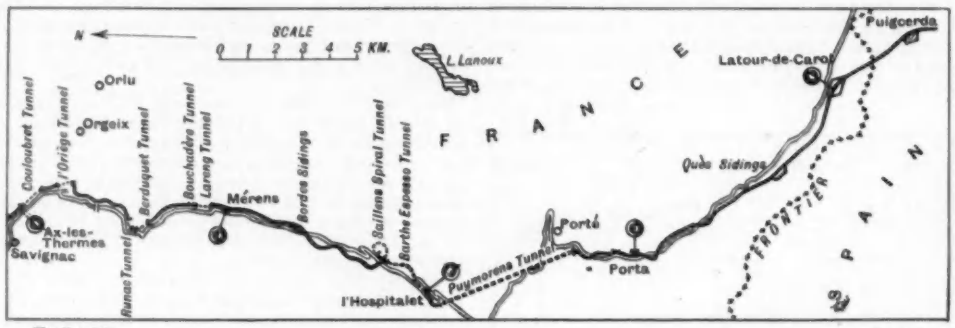


MAP SHOWING RAILWAYS CONNECTING FRANCE AND SPAIN

veyed at a pressure of 150,000 volts to a distributing station at Portet-Saint-Simon near Toulouse. From there it is transmitted to three sub-stations along the line at a pressure of 60,000 volts. The 60,000-volt line is divided into three sections. The first section, which runs from Portet-Saint-Simon to Foix and is 70 kiloms. in length, is composed of three aluminium conductors, having a cross section of 172 square millimetres, suspended on steel towers arranged normally at intervals of 150 m. Between Foix and Ax-les-Thermes—a distance of 50 kiloms.—the line consists of three "Almelec" conductors of 182 square millimetres cross section and the towers used are of the same type as those adopted for the Midi Company's 150,000 transmission line. They are spaced normally at 250 m. apart. Between Ax-les-Thermes and Latour-de-Carol the conductors are of copper, with a cross section of 53·7 square millimetres. Between l'Hospitalet and Porta—that is to say, for crossing the Col de Puymorens—the transmission line is doubled with a view to avoiding interruption of the service by avalanches or storms. The normal span of the line is 90 m. For the whole length of the line the conductors are suspended from the towers by chains of insulators of the "bonnet and stalk" type of the Compagnie Générale d'Electrocéramique.

The catenary suspension line is of the type usually employed by the Midi Company, but, as on the Bedous-Canfranc line, the 79 square millimetre steel supporting cable, which is ordinarily used on the Midi, has been replaced by a bronze cable of 140 square millimetre cross section, excepting in the Barthe-Espesso and Puymorens tunnels, where its place is taken by a copper cable of 244 square millimetres cross section.

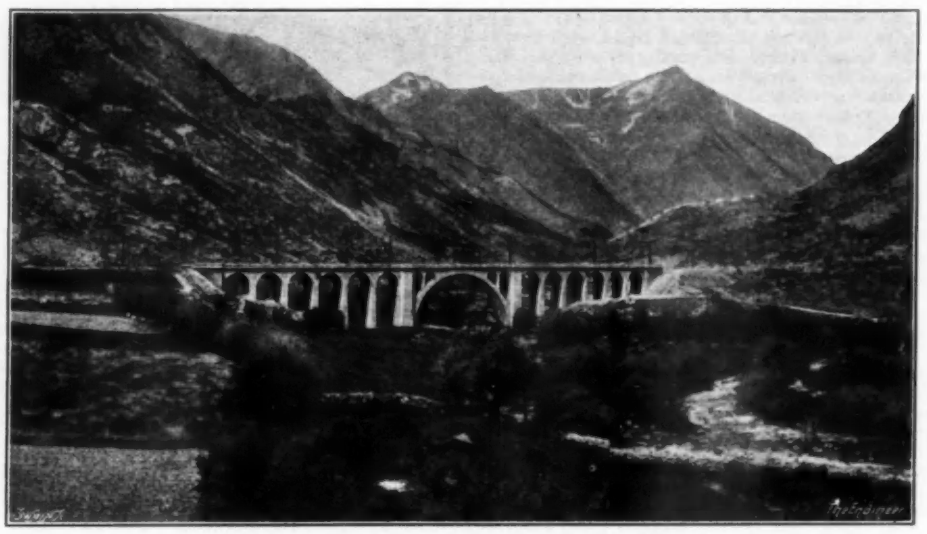
The three sub-stations are at Ax-le-Thermes, l'Hospitalet, and Latour-de-Carol. All of them are similarly equipped and for the time being they are all manually operated. Very shortly, however, those at Ax-les-Thermes and l'Hospitalet are to be altered for automatic operation. Each station comprises two groups, each of 2000-kW capacity, and each is composed of a transformer and two 1000-kW, 750-volt rotary converters, the direct-current sides of these two machines being run in series, so as to produce the required line voltage of 1500. The 60,000-volt windings, six-phase, double-star, 595 volts, at which pressure the current is supplied to the rotaries. The voltages of the subsidiary transformers are 10,000/200/115 and 595/200/115 respectively. From each sub-station two 1500 circuits, each of 2000 ampères capacity, supply current to the overhead line of the railway.



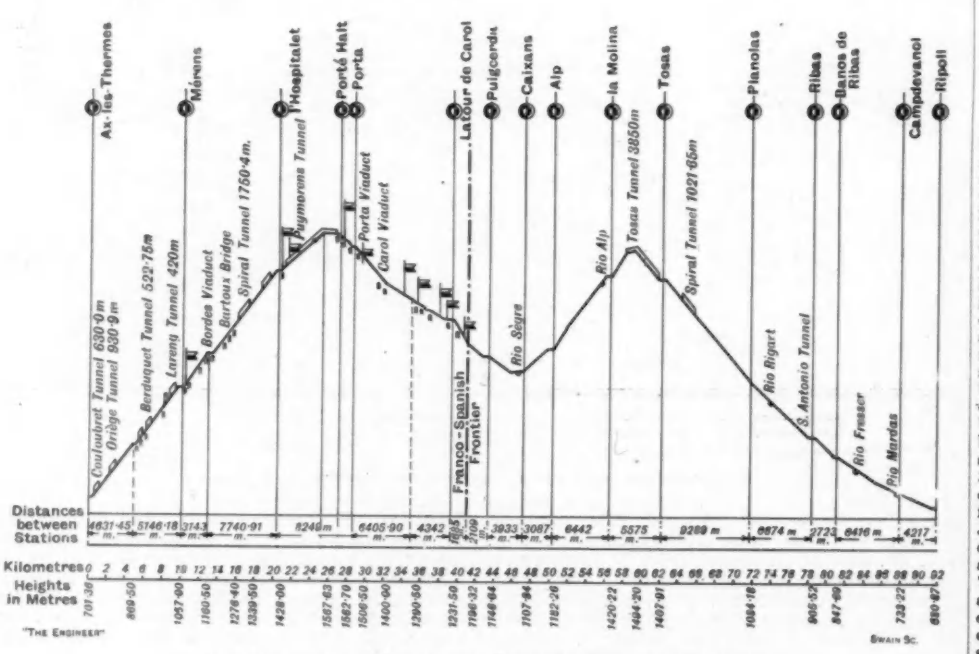
PLAN OF LINE BETWEEN AX-LES-THERMES AND PUIGCERDA

On the new line, as on the Bedous-Canfranc line, which has very similar gradients, passenger trains weighing 300 tons and goods trains weighing 360 tons are employed. They are hauled by two locomotives, type "B.B." of the series which the Midi Company introduced last year for service on the first transpyrenean line. These locomotives have a length over buffers of 12·87 m., say 42ft. 3in., and they weigh 76 metric tons, which is all adhesive weight, as each of the four axles is driven. Theoretically, these locomotives are capable of developing 1000 horse-power continuously, or 1400 horse-power on a one hour rating. In actual service, however, it is found that they are capable of developing 1400 horse-power continuously and up to 1800 horse-power on a one hour rating. Their maximum speed is 75 kiloms. per hour. These locomotives are operated electro-pneumatically, the necessary compressed air for working them and for the brakes of engine and train being produced in two compressors, made by the French Westinghouse Brake Company, which are driven by 1500-volt direct-current motors. An accumulator battery of the alkali type, and motor-driven fans for cooling the motors also form parts of the equipment. The engines were made by the Société des Constructions Electriques de France.

This new line will considerably improve the means of communication between France and Barcelona, and the improvement will be so important that the Spanish Government has decided to prolong the normal French gauge of line as far as Barcelona, which will do away with the necessity of transshipping passengers and goods at Latour-de-Carol and Puigcerda. The alteration of the Spanish gauge of 1·67 m. to 1·44 m. is, in fact, actually being carried out, and it is anticipated that it will be completed towards the end of 1930. The line from Barcelona to Puigcerda, which, as we have said, was opened for service with steam locomotives in 1922, has already been electrified. The facilities for traffic between the important Spanish port and France will, by these means, be very considerably increased. The transport of oranges between France and Central Europe will, for example, be rendered far more expeditious than it has hitherto been, because, in addition to the shortened transit, the fruit will be conveyed direct and will not have to be transferred from one train to another.



MASONRY BRIDGE OVER RIVER CAROL



PROFILE OF LINE BETWEEN AX-LES-THERMES AND RIPOLL

Tests of an "Atmos" High-pressure Boiler.

THE essential feature of the "Atmos" boiler, invented by Mr. Viktor Blomqvist, consisted, as our readers will remember, in the continuous rotation of the tubes in which the steam was generated. The idea underlying the design was that the water, by reason of its centrifugal force, would form a perfect fluid lining to the tubes, the bubbles being driven inward and the steam passing away along the centre of each tube. The impossibility of anything of the nature of foaming in the tubes was favourable to high rate of heat transmission, and therefore of evaporation without fear of overheating the tubes. The first "Atmos" boiler ever constructed was erected in 1915, and consisted of a single horizontal tube rotating at 300 revolutions per minute, and producing steam at a pressure of 750 lb. per square inch. This was followed in 1921 by a six-tube boiler, supplying 6600 lb. of steam per hour at a pressure of 900 lb. per square inch, erected in the Swedish Sugar Works at Gothenburg. Two years later a second "Atmos" boiler, designed for 1500 lb. pressure was erected in the same factory. This boiler consisted of four rotating tubes, 305 mm. outside diameter, having a length of 3400 mm. exposed to the furnace, an economiser and a superheater forming part of the unit. Tests carried out by Professor Josse on site in June, 1924, showed that it gave an hourly evaporation of 8615 lb. of steam at 1500 lb. pressure and a temperature of 750 deg. Fah., with an efficiency of 73·2 per cent. This comparatively low efficiency was attributed partly to an insufficient surface of the gilled economiser employed, and partly to the unsuitable design of the furnace. A later boiler, also of the four-tube design, supplied to the Fors Cellulose Works, in Sweden, produced 11,020 lb. of steam at 1500 lb. per square inch and 824 deg. Fah., with an overall efficiency of 80·4 per cent., the guarantees as to both output and efficiency being surpassed.

A few years ago a licence to manufacture the "Atmos" boiler was acquired by the Société Alsacienne de Constructions Mécaniques, which describes its development at its hands in a recent issue of its *Bulletin*. In the

original Swedish design the water entered the rotating tubes at one end and the steam left at the other, the construction involving two stuffing-boxes as well as some kind of bracing to take up the end thrust. The arrangement was altered first by bringing the two stuffing-boxes to the same end, where their thrust could be balanced more simply, and, finally, by suppressing one of them altogether. Experiments were also made with a view to determining the effect of speed of rotation on heat transmission, and it was found that the speed of 300 revolutions per minute or so, typical of the earlier "Atmos" boilers, could be reduced to less than 30 per minute without ill effect. With the idea of constructing rotors of greater individual evaporative capacity without sacrificing the essential features of the boiler, the Société Alsacienne devised a rotor of what may be called the squirrel-cage type. It consisted of one comparatively large central tube surrounded by a number of smaller tubes lying axially along its circumference, and connected to it at each end. A rotor of this kind, with a central tube, 305 mm. in diameter by 3500 mm. long, surrounded by twelve tubes of the same length and 102 mm. diameter, was fitted to an existing 1500 lb. "Atmos" boiler, in place of the two simple rotors previously employed. The results were most encouraging, the output of the boiler being increased from the original 5280 lb. to 8800 lb. per hour, and 11,000 lb. being obtainable with forced firing. In addition to this boiler, the company had in operation an "Atmos" boiler with two simple rotors, supplying normally 22,000 lb. to 30,000 lb. of steam per hour to its works, at a pressure of 1560 lb. per square inch, and a temperature of 842 deg. Fah. It had been the original intention to fit this boiler with a total of eight simple rotors, but the experiments with the squirrel-cage rotor were so successful that the plans were changed, and the two simple rotors were replaced by two of the squirrel-cage type. The latter carried eighteen tubes surrounding the central tube, giving a total heating surface of 247·6 square feet per rotor. The rotors were driven by spur and worm reduction gearing from an electric motor. They ran at 20 revolutions per minute, and altogether about 2 horse-power was required to drive them. On the motor shaft was fixed a heavy fly-wheel designed to store sufficient energy to keep the rotors turning for about half an hour, in case of any interruption of the electric power supply. The rotors were held against axial movement at their front ends, and expanded freely towards the rear. At the hinder bearing of each rotor were instruments to indicate the amount of expansion, both of the central tube and of the ring of outer tubes. Should overheating occur through shortness of water or any other cause, these indicators warned the operator. They might be caused at the same time to blow a whistle, release the safety valves, stop the introduction of fuel, or take other steps to ensure the safety of the boiler.

The high-pressure steam from the boiler in question is used to drive an impulse turbine. The turbine runs at 10,300 revolutions per minute, and drives a 700-kW alternator, by means of gearing, at 3000 revolutions per minute. Steam is admitted at 1140 lb. per square inch and 750 deg. Fah., and exhausts at a pressure of from 170 lb. to 210 lb. per square inch. It is then re-superheated to 660 deg. Fah., and sent into the main steam range of the low-pressure boilers.

This boiler was tested recently by the Association Alsacienne des Propriétaires d'Appareils à Vapeur, a translation of the report of which we give below :—

Mulhouse, June 29th, 1929.

GENTLEMEN,—We have the honour to hand you herewith the result of our observations, made on the 13th and 14th inst., on the operation of the "S.A.C.M.-Atmos" boiler, with squirrel-cage rotor, which has been in service for some time at your Mulhouse works.

The object of our observations was to note the behaviour of the boiler under industrial conditions. Readings were commenced at noon on the 13th inst., and were concluded at the same hour the following day, so as to include all operating conditions during a complete cycle of twenty-four hours.

BRIEF DESCRIPTION OF THE INSTALLATION.

The boiler, which is built for a pressure of 110 kilos. per square centimetre (1565 lb. per square inch), comprises two squirrel-cage rotors, each of a heating surface of 23 square metres (247·5 square feet), arranged in the longitudinal direction. The superheater is mounted immediately above them, and flanked on each side by one-half of the feed-water heater. The two halves of the latter are arranged in parallel as regards the water circulation, and each presents two passes in series for the flue gases. The latter are delivered into a steel chimney by means of an induced draft fan.

The rotors are placed in the upper part of a pulverised coal furnace fitted with two burners and arranged for the fusion of the ash. The side walls as well as a part of the back wall are hollow, and contain passages through which the secondary air circulates before it enters the combustion chamber. Circulation is assured by a special fan, which draws air from the outside and delivers it through the passages. The equipment comprises a coal dryer, through which is passed a part of the gas from the lower part of the combustion chamber mixed with air from the outside. This mixture after leaving the dryer passes through the pulveriser, which is of the Rex type. Here it picks up the powdered coal, being then withdrawn by two ejectors, which deliver the mixture to the burners.

The feed-water circuit comprises two stages, the first working at a low pressure of about 15 lb. per square inch, and the second at a pressure corresponding to that of the boiler. In the first stage, in which circulation is caused by a centrifugal pump, driven directly by the motor which turns the rotors, the water obtains heat from the auxiliary condensers forming part of the automatic feed regulating system, and from the cooling pipes which protect the arch over the superheaters and economisers. The high-pressure stage is connected to the low-pressure stage by two reciprocating feed pumps, one steam-driven, and one electrically driven. These pumps deliver a fixed quantity of water, the excess over that required by the boilers being returned to the suction side.

The steam produced by this boiler supplies a back-pressure turbo-generator of 600-kW capacity, in which it is expanded from about 1140 lb. to 185 lb. per square inch. When this set is stopped the steam is passed into the works range through a hand-operated valve, by means of which it is throttled down to 170 lb. per square inch.

NATURE OF THE OBSERVATIONS.

To determine the conditions of operation the following readings were taken every 15 minutes :—

(1) Quantity of water evaporated.
(2) Pressure and temperature of superheated steam.
(3) Feed-water temperature at entrance to low-pressure system.

And, further, to enable an idea of the general efficiency of the plant to be formed, there were also noted :—

(4) The temperature and composition of the gases at the economiser exit.
(5) The power delivered by the back-pressure turbo-generator.

All these readings were taken by means of commercial instruments mounted on site, the errors of the instruments being determined by direct comparison with our standard instruments during the trials, and afterwards allowed for.

As regards the measurement of the evaporation, this was taken as the difference between the total quantity of water delivered by the high-pressure feed pumps, and the quantity returned by the automatic feed regulator, and lost by leakage through various valves. The total delivery was read from a screw-meter calibrated by ourselves, while the leakage was estimated by twice collecting the drains in a calibrated tank and noting the time necessary to fill it.

To give a general idea of the operation, the readings taken have been plotted on the accompanying diagram.

CONDITIONS OF OPERATION NOTED.

It was decided that the rate of combustion should be raised to the limit imposed by the capacity of the secondary air fan, care being taken to maintain a furnace temperature compatible with the safety of the furnace walls. So long as the high-pressure turbine was working, the output of steam and consequently the maintenance of the boiler pressure were regulated by the load on the turbine. After the latter was stopped, output was regulated by the throttle valve inserted in the connection to the steam range of the works. In this latter case, however, an endeavour was made to reduce the output as much as possible without stopping the burners. As regards pressure, it was agreed to reduce this also, after the turbine was stopped, to a point only sufficiently high to allow the output of the boiler to pass through the throttle valve.

As has been mentioned above, the observations covered a period of twenty-four hours, from noon on June 13th, to noon on June 14th. On the morning of the 13th, the boiler, which had already been working several days for the purpose of driving the turbine, was lit up in our presence between 7 and 7.30 a.m., after which it worked normally till noon. At half-past eleven, as usual, the turbine was stopped and the steam turned into the works range, the fire being eased as much as possible. The output of steam fell in 27 minutes from 11 to 6·5 tons ; the pressure from 1140 lb. to 900 lb.; and the temperature from 707 deg. to 644 deg. Fah.

At a quarter past one, by which time the output had fallen to 6 tons per hour, the pressure to 855 lb., and the temperature to 527 deg. Fah., the rate of combustion was increased to re-establish normal conditions as quickly as possible.

At half-past one the boiler was delivering 9 tons of steam per hour at 1070 lb. and 608 deg. Fah., and at 1.46 p.m. the high-pressure turbine could take the load. Exactly one hour after the fire had been speeded up, normal conditions were re-established, the boiler delivering 11 tons of steam per hour at 1420 lb., and 734 deg. Fah. to the turbine, and the latter giving a mean output of 650 kW.

At 5.20 p.m., when work ceased in the greater part of the factory, the turbine and the boiler were both shut down, the output of the boiler being at the time 11·5 tons per hour at 1200 lb. per square inch and 653 deg. Fah. The steam generated by the heat in the furnace brickwork was turned into the works range, and the pressure dropped rapidly. It fell to 310 lb. and 518 deg. Fah. in a quarter of an hour, and to zero in 1 hour and 55 minutes after the burners were shut off, when the valves were shut. The pressure then started to rise again, standing for about a quarter of an hour at 1270 lb. towards 8.30 p.m. Half an hour after, it had again fallen to about 285 lb., at which it remained till the next morning.

On June 14th the feed pumps were started at 7 a.m., and the fire was lit by an oil burner 18 minutes later. At 7.34 a.m. the two pulverised coal burners were started. The steam pressure, which up to that time had risen very slowly from its initial value of 285 lb., increased rapidly to 825 lb. at 7.38 a.m. At this moment the junction valve was opened, and the steam flow was almost instantly recorded as 11 tons per hour, falling to 8 tons per hour by 8.5 a.m. The pressure being 1420 lb. at this time, and the temperature 698 deg. Fah., the turbine which had hitherto been idling was loaded up to 265 kW. A short time afterwards the boiler output settled down to about 11·6 tons of steam per hour at a pressure of 1420 lb. and a temperature of 707 deg. to 750 deg. Fah. As to the turbine, it delivered an average of 660 kW, with a peak of 710 kW, due to a temporary fall in the back pressure.

At 11.33 a.m. the turbine, the load of which, in anticipation of the dinner hour, had fallen to 550 kW, was stopped, and, as had been done on the day before, the steam was turned into the works mains until the recommencement of work at half-past one.

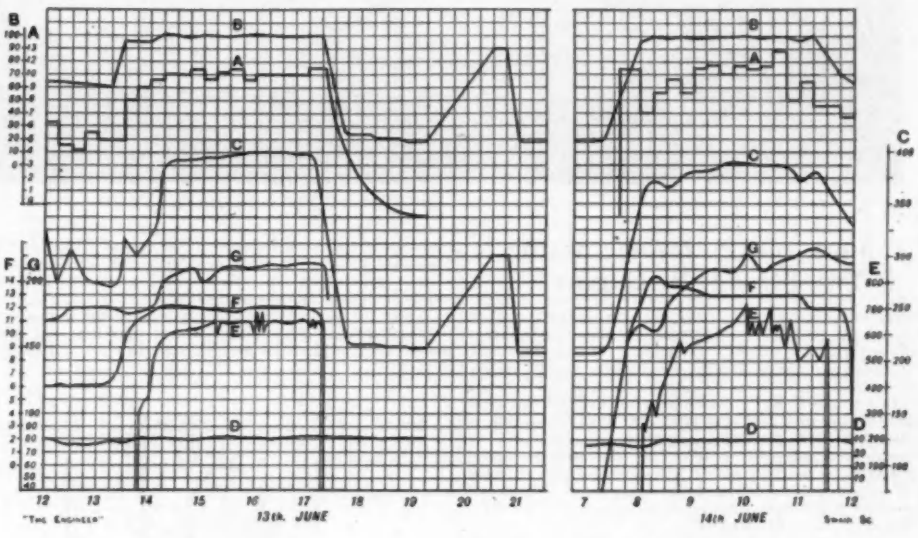
SUMMARY OF THE OBSERVATIONS.

During the period of twenty-four hours the boiler was on load for 11 hours 37 minutes, and the turbo-generator for 7 hours 2 minutes, consuming 163,240 lb. of steam and producing 4100 kWh. During the warming up of the turbine, which lasted 41 minutes, the boiler produced an extra 18,040 lb. of steam, of which a large part was taken by the works mains. A further 36,960 lb. of steam was delivered into the mains during the 2 hours 47 minutes that the turbine was stopped. It may be mentioned also that the heat absorbed by the brickwork was sufficient to produce 10,560 lb. of steam.

During the whole of the time the plant was under observation, its working was perfectly regular. The flue gases entered the chimney with between 12 and 13 per cent. of CO_2, and an average temperature of 410 deg. Fah. It was only during the short periods when the excess air was a little too great that the flue gas temperature approached 446 deg. Fah.

The automatic control of the feed water worked satisfactorily, and only became irregular at times of great variation of pressure, when it was necessary to control the feed by hand until the pressure once more became steady. The stand-by steam pump was run constantly at slow speed, but there was never any occasion to demand its services, the electric pump alone maintaining the high-pressure feed-water supply during the test.

J. KAMMERER,
Engineer-in-Chief.



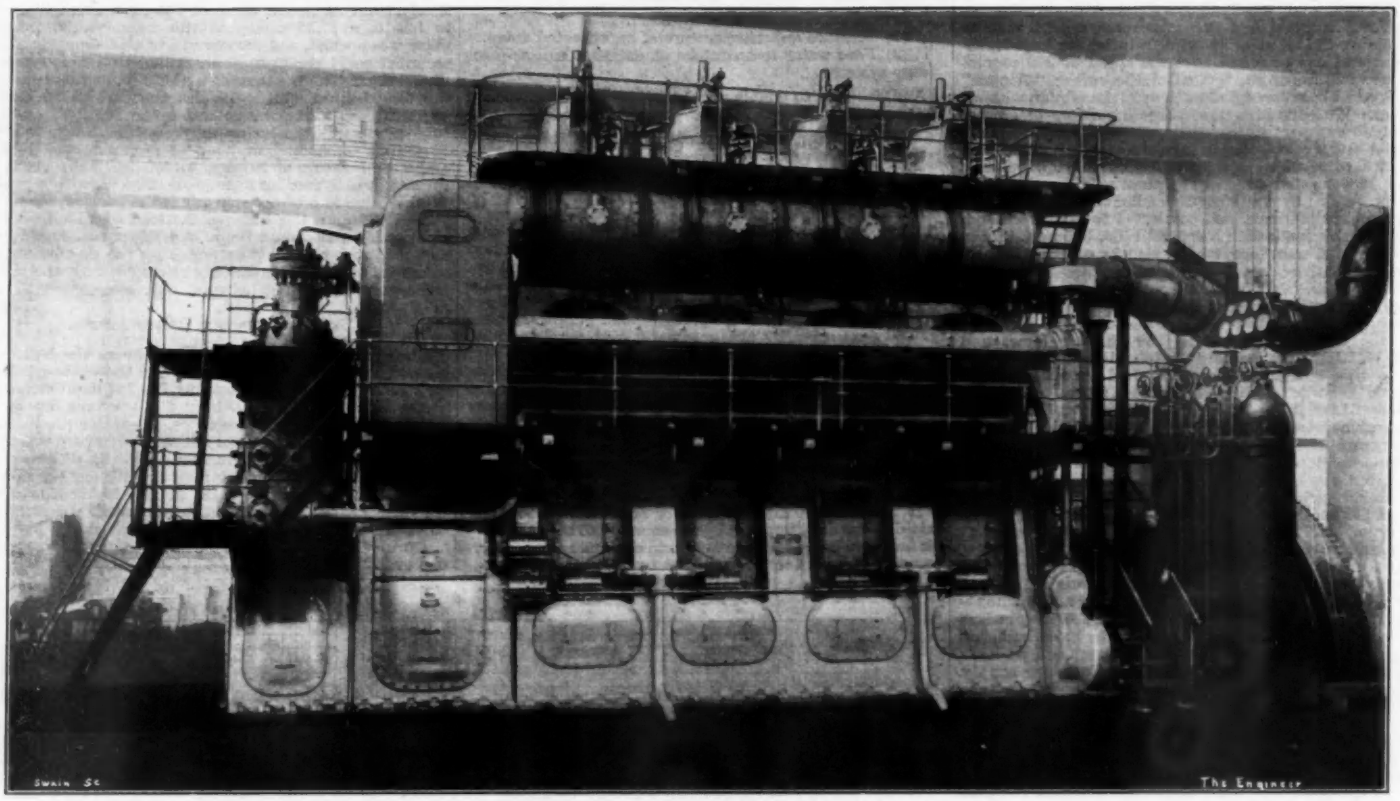
A, Output of steam in tons per hour.
B, Steam pressure in atmospheres.
C, Steam temperature in degrees Centigrade.
D, Feed-water temperature in degrees Centigrade.
E, Output at generator terminals in kW.
F, Percentage of CO_2 in flue gases.
G, Temperature of flue gases in degrees Centigrade.

BOOKS OF REFERENCE.

"FOUNDRYMEN'S HANDBOOK." Second edition. London : The Penton Publishing Company, Ltd., Caxton House, S.W. 1.—Price 30s. net.—The first edition of this book of reference was published in 1922. For some fifteen years previously, the *Foundry*, of Cleveland, Ohio, had regularly published series of Data Sheets, which were only printed on one side of the paper and were intended for clipping and preserving in note-books. A demand arose for their publication in book form, and it was met by the publication of the first edition of the handbook. In the present edition over 250 pages of new material have been added. They not only amplify some of the data contained in the first volume but also add to the knowledge of other phases of the foundry industry which were not known seven years ago. Some of the older material that was not consistent with modern methods, or was seldom referred to, has been omitted. Numerous changes have been made in arrangement, and several new sections or departments have been added. They include a Lexicon of Technical Terms, Routine Analyses, and Care and Maintenance of Equipment. The volume contains an enormous quantity of interesting information, and its value is enhanced by a voluminous index which runs to over 20 pages of small type.

FOUR-CYLINDER 4000 B.H.P. DOUBLE-ACTING TWO-STROKE OIL ENGINE

CARELS' WORKS (S.E.M.), GHENT, ENGINEERS



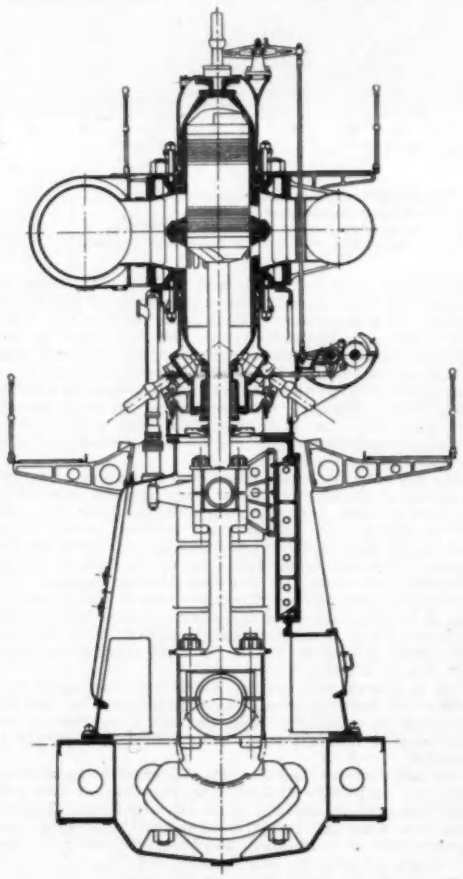
A 4000 B.H.P. Double-Acting Two-Stroke Oil Engine.

Some months ago we were able to announce that arrangements had been made whereby the Worthington double-acting, two-stroke oil engine would be built under licence at Carels Works, Ghent, now known as the Société d'Electricité et de Méchanique (S.E.M.), of Ghent. It will be recalled that a full account of the Worthington single-cylinder test unit was given in The Engineer of October 3rd, 1924, while the shop trials were published in our issue of April 23rd, 1926. The first marine engine of this type to be built was a four-cylinder unit of 2950 S.H.P., which was installed in the cargo vessel "Tampa." The results of the first voyage of this ship were published in The Engineer of December 31st, 1926. The second vessel so equipped was the "Unicoi," and both installations have now seen considerable sea service.

The first unit built in Ghent is, as our illustration above shows, a four-cylinder engine. It has a designed output of 4000 B.H.P., and each cylinder has a bore of 28in., with a stroke of 40in. The running speed is 128 r.p.m., and in service the engine will develop about 3850 B.H.P. and will be directly coupled to a 2600-kW General Electric Company's alternator. The generating unit is the first of two similar sets to be installed in the Cordoba power station in the Argentine.

While following in the main the design of the American engine, the new unit has incorporated in it some small variation in design and construction which have been introduced by the Belgian builders. Thus, in the two marine engines above referred to, the scavenge air pump was placed in the centre of the engine, but in the Carels design this is mounted along with the three-stage compressor on an extension of the bed-plate, remote from the fly-wheel end of the engine. The above is a view from the scavenge main side of the engine, and clearly shows the new pump arrangement. The cross-sectional drawing reproduced herewith indicates the principal features of the design. Each of four cylinders forms a separate unit, and these are bolted together to form one substantial framing which is mounted on a deep bed-plate of box form. The crank case is furnished with large inspection doors, and on the side opposite to the crosshead guides—not shown above—there are large aluminium inspection doors, which give access to all running parts. On the top of the crank case there is mounted an extension piece to which the cylinder base is attached. This casting is of rectangular box form, and is utilised for the discharge of the exhaust gases on one side and admission of the scavenge air on the other side. The base is secured by four tension bolts passing through the crank case to the underside of the bed-plate, and is thus relieved from tensional stresses. The liners, both top and bottom, are made in two parts. An inner liner carries the exhaust and scavenge air ports, and this is pressed into an outer or main liner, which is of a domed shape, and is machined from a mild steel forging. Before assembly, this liner is covered by a light jacket which encloses the water cooling spaces. The outer surface of the steel liner is furnished with a series of annular grooves, which are designed to promote efficient cooling. The upper and lower liners and cylinders are held in position by clamping rings attached to the cylinder base. There is a single fuel valve for the upper cylinder, which is operated by a lever and vertical pushrod from a cam shaft situated just above the crank case. A short horizontal rod serves to work the two fuel valves for the lower cylinder, which are inclined at an angle of about 45 deg. The piston is tapered off at the upper and lower ends to fit the domed shape of the cylinder liner and the top and bottom surfaces are furnished with deflecting ridges, which guide the flow of the scavenge air. The heads of the pistons are made of a carbon steel.

Water for cooling the cylinders is admitted at the centre of the cylinder base, and it flows upwards and downwards to the liner jackets in separate cooling circuits,



SECTION OF ENGINE

the discharge from either circuit being regulated by a valve. In practice a velocity of about 3ft. per second is maintained. For cooling the pistons, the water is taken through telescope tubes, shown to the left of the drawing, passes up a central tube in the piston-rod, and returns down the annular space around the tube. The water cooling arrangements are easily accessible. Between the crank case and the extension piece there is a light stuffing-box, above which the piston-rod can be seen, while immediately above this is the main stuffing-box for the lower cylinder. The design of this box is such that the metallic packing can be removed in one piece. As the unit we have described will be used for alternator driving, a speed-regulating governor has been fitted, which will be seen to the right-hand end of the engine.

In our issues of May 5th and May 19th, 1922, we described the Carels Works after their reorganisation, following the period of German occupation during the war, after which an extensive replacement of machinery and equipment was found to be necessary. We are able to state that further shops and machinery extensions are now in progress, which, when completed, will greatly increase the output of the works. These include a new test bed for large oil engines, part of which is shown in the accompanying engraving.

B.E.S.A. SPECIFICATIONS.

HARD DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT (No. 165–1929).

The British Engineering Standards Association has recently issued a Specification for Hard Drawn Steel Wire for Concrete Reinforcement (B.S.S. No. 165–1929). The tensile strength of the wire is required to be between 37 and 42 tons per square inch with a minimum elongation of 7½ per cent. and provision is made for testing wire of other than round section. A cold bend test is specified.

Heat-treated wire is not covered by this specification, but will be dealt with in the new issue of the B.S. Specification No. 15 for Structural Steel for Bridges and General Building Construction, which it is expected to complete shortly.

CONCRETE FLAGS IN PORTLAND CEMENT (No. 368, 1929).

The British Engineering Standards Association has recently issued a further specification relating to road materials, namely, for Concrete Flags in Portland Cement. This specification corresponds closely with that issued last year for Concrete Kerbs, Channels and Quadrants, and contains requirements as to the aggregate, the preparation of the concrete, and the moulding, and includes tests for transverse strength, rate of wear, and absorption, and a minimum weight per cubic foot. Provision is made for the use of rapid-hardening cement. Four sizes of flags, each in two thicknesses, have been standardised.

Copies of specifications Nos. 165 and 368, 1929, may be obtained from the Publications Department of the British Engineering Standards Association, 28, Victoria-street, S.W. 1, price 2s. 2d. post free.

The Swedish Commission for Industrial Standardisation in its latest report, just published, states that it is now working on the international standardising of lengths for sawn and planed wood goods, and that a conference for that purpose will be held in London shortly. Through standardised length measurements for wood the Swedish sawmill industry would, it is stated, save more than six million kronor—£330,000—annually. The question of standard dimensions of paving stones has also been taken up, and, if carried through, would mean an annual saving of at least 500,000 kronor—£27,778—to the stone industry.

132 kV TRANSFORMER WITH ON-LOAD TAP-CHANGING GEAR

THE ENGLISH ELECTRIC CO., LTD., STAFFORD, ENGINEERS

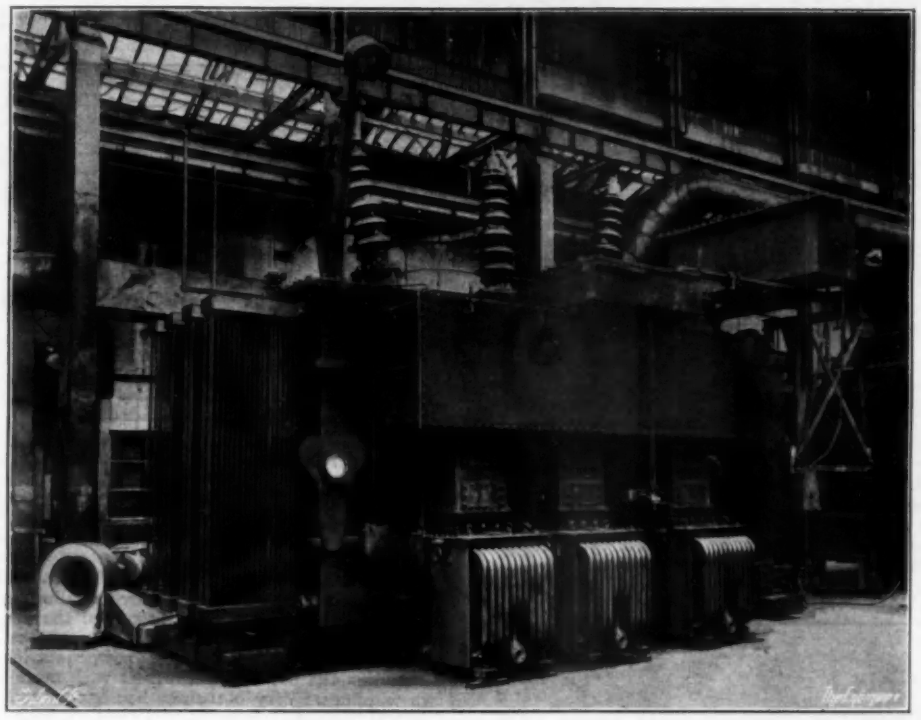


FIG. 1

A Visit to the Stafford Works of the English Electric Company.

No one who takes an interest in electrical engineering, especially heavy engineering, can fail to appreciate a visit to a large electrical works at the present time. Never before have the electrical manufacturers had more important contracts on hand; never have they been engaged upon more interesting work. The British "Grid" has created a large demand for high-tension apparatus, differing in design and construction from that hitherto employed in this country.

Besides these Grid contracts, electrical manufacturers are, of course, dealing with other British contracts, and contracts secured in various parts abroad. The shops of the large electrical firms are therefore quite busy. Nowhere, so far as we have been

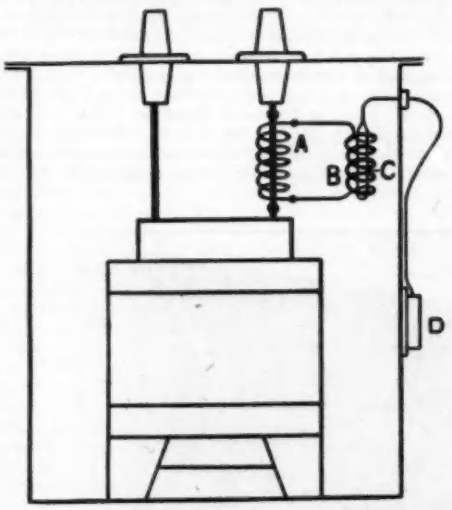


FIG. 2—TRANSFORMER WINDING TEMPERATURE INDICATOR

able to discover, is there any real shortage of electrical work. Whatever may be the ultimate effect of the Grid on the general welfare of this country, there is no question that it is providing a large amount of employment at the present time, not only in the electrical industry itself, but in other industries which must of necessity provide certain raw materials and goods.

The Stafford factory of the English Electric Company is, of course, one of the largest of its kind in England, and if it were combined with the company's other factories at Preston and Rugby, it would, we imagine, be the largest of all. To keep such a big concern as that at Stafford working at full pitch demands a constant supply of big orders, and the responsibility which rests on the shoulders of the commercial organisation is great. But no lack of work is being experienced in these days. Although on the occasion of a recent visit to this factory, the bulk of the workpeople were on their summer holiday, quite a number had been persuaded to carry on, and all the shops showed signs of great activity. While many of the machine tools were, of course, idle, and many benches were unoccupied, it was evident from the large display of finished and partially finished products that the works as a whole were enjoying a prosperous time. Transformers totalling several hundred thousand kilovolt-

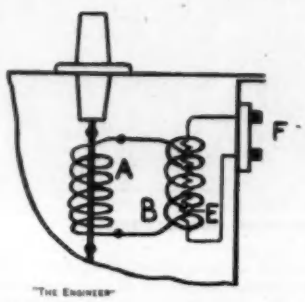


FIG.—3 INDICATOR WITH RESISTANCE ELEMENT

ampères were in the course of manufacture, including 132-kV, three-phase transformers, with on-load tap-changing equipment for the Central Scotland scheme. The tap-changing gear for these transformers—see Fig. 1—was described in our issue of August 16th. Besides these big 132-kV transformers, a large number of 33-kV transformers were being constructed for the South-East England, Central England, and North-West England schemes, all self-cooled and fitted with on-load tap-changing gear on the 33-kV side.

Mr. R. M. Charley, who is at the head of the transformer department, explained many points relating to the English Electric Company's transformers. One of the things he told us was that it is now possible to transport by rail and under ordinary traffic conditions, three-phase 132-kV transformers, designed for an output of 75,000 kVA, and weighing ready for transport about 98 tons. The core and windings are transported in their own tank, which also contains the oil, but naturally the bushings, on-load tap-changing gear, and other fittings are detached. Rolling stock is now available with detachable side frames arranged so that the transformer rests in the trolley with the bottom fairly near the ground, thus making the removal of the transformer a simple and straightforward job. By transporting large transformers in this way, with the oil in the tank, the troublesome task of drying out the windings on site is avoided. The facilities that exist in manufacturer's works for the purpose of drying out transformers are, of course, far better than those that can be secured on the site; hence the possibility of being able to send large transformers away in their own tanks, together with the oil, and dried out ready for service, is a very great advantage.

One of the greatest problems associated with the transportation of very large three-phase transformers is to keep down the height; but it has been found that the difficulties in this direction can be minimised by the adoption of the five-limb core type construction. The cross section of the yoke of the ordinary three-phase core must be the same as that of the limbs, whereas in the five-limb core the cross section of both yokes is only half that of the main limbs. The depth of the two yokes is consequently

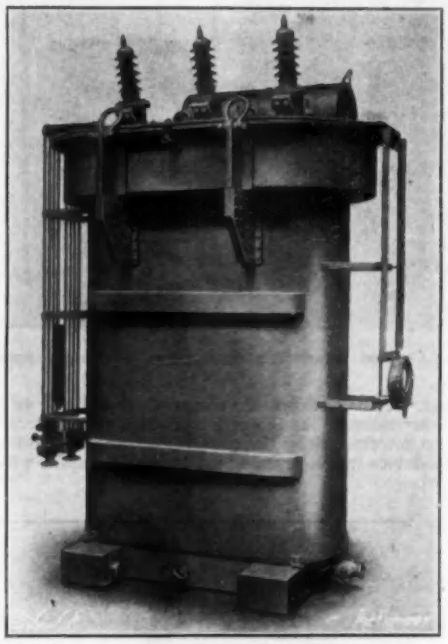


FIG. 4—THREE-WINDING TRANSFORMER

reduced by half, and on a large transformer this reduction may amount to as much as 24in. to 30in. Needless to say, this assists very materially in reducing the overall height to the necessary limits. Another valuable feature of the construction is that with the reduced depth of the top yoke the problem of interleaving the laminations is comparatively simple. Butt-jointed yokes are avoided. Even on the biggest transformers it is possible to use interleaved joints, which are far preferable to butt joints. The magnetic circuits of the three phases of these five-limb transformers are also more symmetrical than those of the ordinary three-phase core. The exciting currents in the three phases are pretty well balanced, a distinct advantage from the point of view of balanced protective gear.

All English Electric transformers for the Grid scheme, we were told, are designed to give 50 per cent. or more of their full load output as naturally

FIG. 5—AIR-BLAST TRANSFORMER

cooled transformers. Under normal operating conditions a grid sub-station will have two transformers in parallel, carrying between them the full load of the line. Each transformer will, therefore, only carry half the load, and will operate as a self-cooled transformer, thus eliminating the supervision of auxiliaries. But in case of emergency, or in the event of the load rising above normal, auxiliary cooling

apparatus will be automatically brought into action by means of a relay actuated in accordance with the winding temperature of the transformer, although the temperature at which the relay will close will not, of course, coincide exactly with 50 per cent. of the full load, for the ambient air temperature is likely to be below normal. As the safe load on a transformer is only determined by the temperature of the winding, if a device which gives a true indication of the winding temperature be incorporated in the transformer, the amount of load current can be governed by that device. The method of measuring the winding temperature of English Electric transformers is worthy of description. In Figs. 2 and 3, A is a current transformer with its primary in series with the main transformer winding and its secondary connected to an auxiliary coil B. The current in the latter coil is thus proportional to the load. This coil B is immersed in the hottest part of the oil, and it is designed so that the temperature gradient from the inside of the coil to the surrounding oil is the same as that from the main transformer winding to the oil, as determined by resistance. The actual temperature inside the coil B is consequently the same as that of the main winding. A capillary thermometer C is connected to an external thermometer D or, alternatively, the thermometer C may be replaced by a resistance element E—Fig. 3—connected to a suitable indicating or control device, situated at any distant point. Since the thermal capacity of the apparatus is quite small, its time lag is practically negligible. Moreover, this simple apparatus eliminates the risk associated with the practice of inserting resistance or thermo-electric elements in the windings of high-voltage transformers.

The auxiliary cooling agent usually adopted consists of an air blast applied to the radiators which may be attached to the transformer or the complete cooling equipment may take the form of a separate cooler. In either case the equipment is capable of dissipating the losses corresponding to half load. On very large transformers the cooling is further accelerated by inserting a pump in the main pipe connecting the cooler with the transformer, and in this case it is possible, first of all, to start the fan, which will take care of loads up to perhaps 80 per cent. of the maximum load, and when this load is exceeded, the pump is started.

Another interesting development which Mr. Charley brought to our notice was the three-winding transformer. As can be seen from a study of the articles we are now publishing on the Gatineau–Toronto scheme, the interconnection of power stations is demanding the use of transformers with more than two windings. Very big units having as many as four windings are in service, and most of them have on-load tap-changing gear on at least two of their windings. A three-winding transformer, made by the English Electric Company for outdoor service and supplied to Sao Paulo, is shown in Fig. 4. Other transformers of the same type have been supplied. Speaking of transformers with more than two windings, brings us to an interesting application of three-winding transformers. Suppose a 220,000-volt transmission system has to be connected to a 110,000-volt system. At the point of connection there would, of course, be a transformer which would usually be connected star-star. To avoid trouble, owing to third and fifth harmonics, it is generally necessary to provide a tertiary winding which can also be made to supply power to a synchronous condenser for regulating the power factor of the transmission lines. In the absence of the tertiary winding, the synchronous condenser would need a separate transformer, which would, of course, involve considerable additional expense.

Some customers, we were told, still call for air-blast transformers, because they consider that, from the point of view of fire, oil is undesirable. English Electric air-blast transformers are made for pressures up to 12,000 volts. The construction of these transformers is interesting. The windings must be treated with varnish that is absolutely non-hydroscopic, and which gives a perfectly hard and smooth finish in order to reduce the possibility of dirt and dust collecting on the coils. Although an air-blast transformer eliminates the oil and occupies less floor space than an oil-immersed transformer, it requires a motor-driven fan and switchgear to control it. Moreover, it has very little overload capacity as compared with that of an oil-immersed transformer. Two examples of English Electric air-blast transformers are shown in

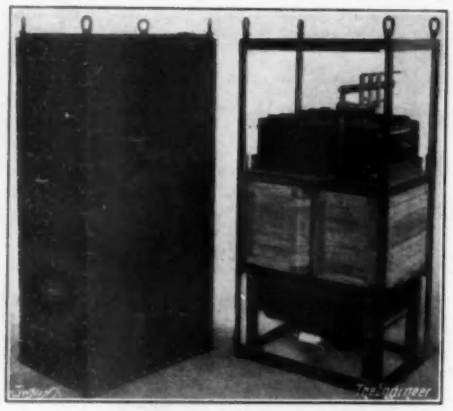


FIG. 6—AIR BLAST TRANSFORMER REMOVED FROM CASE

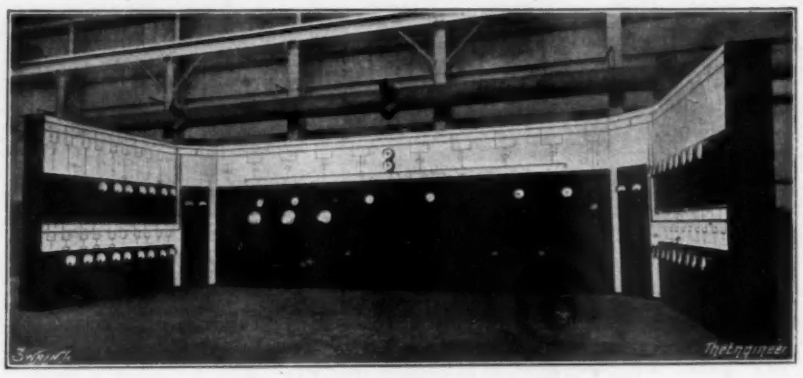
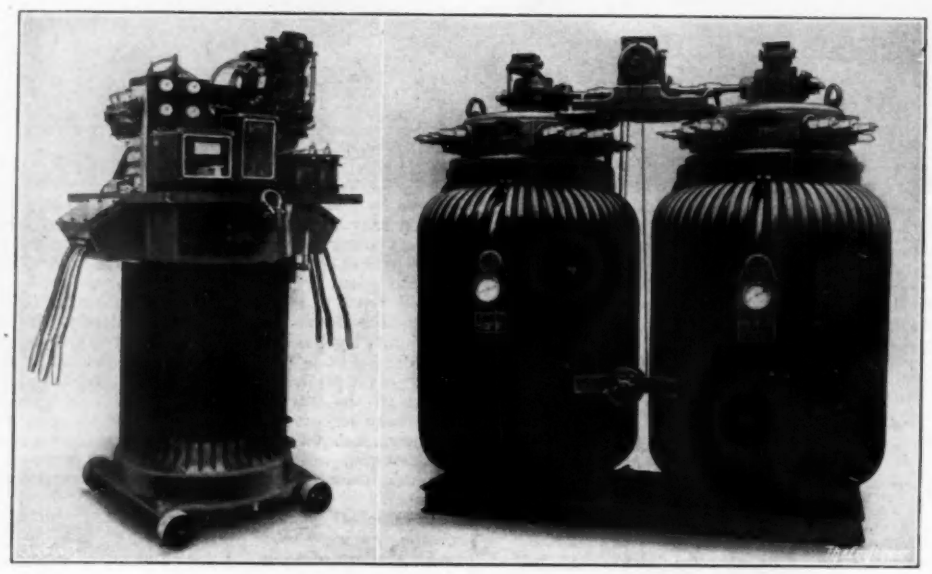


FIG. 10—REMOTE-CONTROLLED SWITCHBOARD



FIGS. 7 AND 8—SINGLE AND TWIN INDUCTION REGULATORS

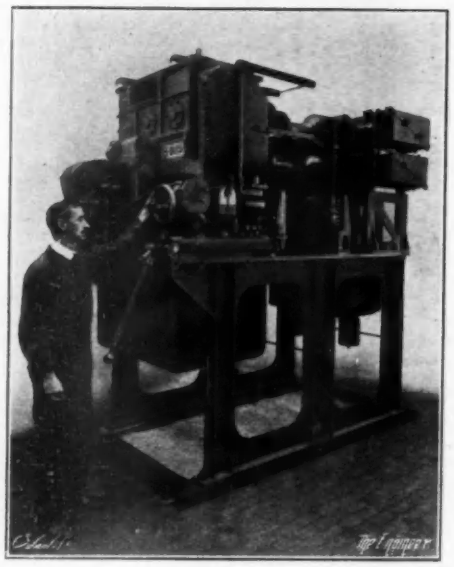


FIG. 9 METAL-CLAD, COMPOUND-FILLED SWITCH

FIG. 11—DESK CONTROL SWITCHBOARD

Figs. 5 and 6. The former is a single-phase, 255-kVA, 33⅓-cycle transformer, designed for 10,600/380 $\sqrt{3}$ volts, and is intended for indoor service. The latter is also a single-phase, 33⅓-cycle transformer. Its output is 715 kVA, and it is of the sheel type. It is wound for 10,500/2 × 374 volts, and is intended for indoor service. Six of these transformers were supplied to the London Electrical Railway in 1927, which also purchased six transformers—as shown in Fig. 5—in 1928.

High-reactance rotary converter transformers, made at the Stafford Works are built on rather special lines. To obtain the desired voltage regulation on the direct-current side of rotary converters it is customary to provide high reactance in the transformer. To secure this reactance it is possible to use a concentric winding with a big distance between the high and low-voltage coils, but unfortunately this scheme is expensive. An alternative method is to use a concentric winding with magnetic shunts between the high and low-voltage coils. This construction presents the disadvantage that it is not an easy matter to arrange for the shunts; it also has the defect that the characteristic curve of the reactance cannot be a straight line, because at some loads the shunts become saturated. When rotaries have to deal with repeated overloads and short circuits, as on traction systems, this is apt to become a serious matter. The English Electric Company therefore uses a sandwich-wound transformer, in which the high and low-voltage windings are split up into groups and interleaved, the number of groups depending on the size of the transformer and the amount of reactance required. With all sandwich-wound transformers the low-voltage winding presents a problem which is solved in the English Electric designs by the use of a patented winding in which the whole group of coils is wound as one continuous spiral without joints. Each coil in the group consists of one turn, and the conductor comprises a number of wires in parallel. To reduce stray losses in this winding to a minimum, a patented cross-over is adopted, whereby the wires at the centre of the turn are interchanged with the wires on the inside and outside of the coil; in other words, the wires on the inner half of the coil are crossed over with those on the outer half.

A few years ago it was considered that Bakelised paper was the most suitable material for the insulation of high-voltage oil-immersed transformers, but the use of this material has now been practically abandoned. Instead, fullerboard is employed. This material has a long fibre and it readily absorbs transformer oil. Its dielectric constant is very similar to that of transformer oil, whereas that of Bakelised paper is quite different. In a transformer containing fullerboard and oil the potential gradient between the point of high voltage and earth is very much more uniform than it is in a transformer insulated with Bakelised paper. Fullerboard offers the additional advantage that it can be moulded into many useful shapes, such as angle rings. The Grid transformer shown in Fig. 1 is entirely insulated with this fullerboard material.

With the development of high-voltage transformers it is very essential to keep the oil in good condition. The use of expansion vessels has proved very advantageous in this connection, because the surface of oil exposed to the atmosphere is extremely small. The oxidation of the surface of the oil is practically negligible, but it is, nevertheless, necessary to purify the oil from time to time, an operation that is usually carried out in a purifier of the centrifugal type. It was formerly considered necessary to pass the oil through the purifier at a comparatively high temperature in order to increase the capacity of the purifier. It has been found, however, that there is a serious objection to purifying the oil at a high temperature. The capacity of oil for the absorption of moisture from the air increases very rapidly with increasing temperature. If the oil is purified at high temperature it absorbs a certain amount of moisture from the air, and on cooling this moisture separates out and may get into dangerous places in the transformer. It is therefore desirable to purify the oil at low temperature. If the oil is in a bad condition, however, it can first of all be passed through the purifier at high temperature and subsequently the circulation can be continued with decreasing temperature until the oil is at atmospheric temperature. Experience indicates that if this method is carefully carried out it is extremely unlikely that the oil will have any appreciable quantity of absorbed moisture when the process has been completed. A further refinement in the purification of oil is secured by the use of an equipment in which the oil is always confined in a closed circuit so that it does not come into contact with the air at any time during the purification process.

No other electrical firm in this country has paid more attention to the design and construction of induction regulators than the English Electric Company. Whenever we have visited the Stafford Works we have always found a large number of these regulators in the shops. For the regulation of large transformers there is no doubt that the on-load tap-changing scheme is distinctly advantageous, but for the regulation of the smaller feeders and for certain other purposes the induction regulator holds its own. For circuits up to about 500 kVA, induction regulators, can we were told, compete quite favourably with an on-load tap-changing transformer. An automatically-controlled induction regulator is a simple piece of apparatus and is admirably suited for the control of certain feeders. A 36·4-kVA fully automatic three-phase 50-cycle induction regulator designed for 415 ± 105 volts between lines and for outdoor service is shown in Fig. 7; whilst Fig. 8 is a 2 × 620-kVA, three-phase, 50-cycle feeder control twin regulator designed for 10,500 ± 525 × 2 volts between lines.

Unfortunately, the limited amount of time at our disposal did not allow us to make a close inspection of the large machine shops, but the rapid tour which we made through them was sufficient to convince us that they were quite busy. Among other large machines in hand are three vertical three-phase 50-cycle alternators for the Perak River Hydro-electric Company, each designed for 12,350 kVA, a speed of 94 revolutions per minute and a pressure of 6600 volts. Mention should also be made of eleven 3000-kilowatt 10,000-ampère armatures, which are to be coupled two in tandem to English Electric water turbines of 9600 horse-power capacity for the British Aluminium Company's Lochaber scheme. Many interesting machines were in the course of construction, but we must now turn to the switchgear shops.

Switchgear manufacture was begun at the Stafford works in a comparatively small way more than twenty-five years ago. In those days switchgear was, of course, quite a minor accessory, for the present systems and high voltages were not even remotely contemplated. But some of the earliest installations supplied from these works are, we were told, still in operation and giving full satisfaction, notwithstanding that the systems on which they are used have grown far beyond the rated capacity of the apparatus. The company's oil circuit breakers, in particular, are claimed to have an unexcelled record for reliable performance under the most severe emergency conditions. During recent years the company's switchgear department has been considerably extended, and the latest addition of a second large erecting bay of 18,000 square feet brought the total of the area devoted to switchgear up to over 100,000 square feet, exclusive of the usual auxiliary departments, such as foundry, pattern shops, smithies, tool shops, main testing and despatch departments, which serve the whole works. In spite of these recent additions, the switchgear shops appeared to be working at their full capacity.

The general lay-out of the switchgear works is well arranged for economical routing of the processes. In the eastern block of buildings are various bays with the main stores running transversely across them at the northern end. On the extreme east is the machine shop with the finish annexe at one end.

In a small building outside the machine shop on the foundry side is a sand blasting equipment for removing scale, &c., from castings used in compound-filled switchgear, and for giving a fine finish to various special castings.

Parallel to the machine shops are the detail assembly and small assembly shops, in which complete apparatus of the smaller kinds and the main components of larger apparatus are assembled. To facilitate this work there is a calibration, flashing and general testing section attached to the shop, so that sub-assemblies and individual apparatus can be adjusted and checked before final assembly or transference to the adjacent finished goods store.

On the western side is a larger and higher block forming the large assembly shops, leading at its northern end into the main test bay and despatch department. These shops consist of two well-lighted bays 370ft. long and 23ft. 9in. to the crane rail, and serve for the erection of the larger classes of switchgear. A part of one of the bays is set aside for the a sheet metal shop. The large assembly shops are devoted to the erection of large oil circuit breakers, steel structures, kiosks, metal-clad switchgear, and similar large control gear. To facilitate the manufacture of the larger metal-clad pillars, use is made of plates let into the floor in suitable positions, to which the pedestals of various pillars can be bolted.

Electrically-heated ovens and boilers are installed at the end devoted to the erection of compound filled switchgear. The ovens are for drying the castings before filling them and for other miscellaneous work. The boilers—which are fitted with stirring blades to prevent local heating—are arranged for the direct filling of the castings at the correct temperature, so that all compound filling is done at the works under the most scientific and modern conditions.

With the object of simplifying maintenance and of overcoming difficulties hitherto met with, the construction of compound-filled switchgear, the designers of the English Electric gear have introduced certain special features. With a view to preventing leakage at the joints, the compound-filled chambers are filled as described, and are despatched with cover plates bolted over their openings. On erection at the site these plates are removed, and small expansion chambers are fitted, which allow the compound to expand without being forced out between the joints. What is more important, the compound can return to its place when the temperature falls. Air spaces and cavities cannot, therefore, be formed inside the compound-filled chambers. Another feature of the design is the provision of dust and moisture-tight shutters. When the pillar is withdrawn, the shutters —which are provided with a flexible steel lining edged with felt—are pressed on to the spout faces by means of a cam arrangement on the shutter mechanism, thus preventing the accumulation of dust and moisture on the inside lower part of the spout face, which cannot be cleaned without making the whole of the switchgear dead. A metal-clad compound-filled switchboard unit, with an 11,000-volt electrically-operated oil circuit breaker and duplicate bus-bars is shown in Fig. 9.

The special finish annexe is equipped for plating with tin, copper, zinc, silver and nickel, for spray

FIG. 12—440 VOLT 3-PHASE SWITCHBOARD

FIG. 13—METAL-CLAD, COMPOUND-FILLED SWITCHGEAR

coating and stove enamelling. The latest methods of treatment are continually being investigated, and recently experimental work has been carried out on plating with chromium and cadmium. Finish plays a highly important part in switchgear of all kinds, for while protection from corrosion, adaptability to cleanliness, and good appearance are important features, there are also certain problems arising from the Peltier effect which can be largely diminished or eliminated by suitably plating contact surfaces, which for one reason or another are composed of different metals. Extensive use is now made of cellulose paint in various colours for spray coating the interior of relay casings, &c., because it dries quickly, is durable, and presents a good appearance.

The requisite voltages for flash tests for apparatus up to 66 kV working pressure are provided by portable testing sets. Facilities are also provided for carrying out motor and solenoid operation tests, mechanical tests and endurance tests *in situ*, so that, as a rule, it is unnecessary to move finished apparatus into a special test area. For the higher voltages and for testing outdoor apparatus under artificial rain, &c., a special portion of the erecting shop is set aside between the assembly shop and despatch departments, where tests can be carried out up to half a million volts. Testing of complete apparatus in

FIG. 14—6,600 VOLT SWITCHGEAR

conjunction with the plant it has to control is carried out in the main test bay of the works. Needless to say, it is of the greatest advantage to the company and to its clients to be able to make working tests on complete equipments. Automatic sub-stations tested at the works with their own transformers, machines and switchgear, for example, can be despatched absolutely correct in every detail without having to rely on site tests to any appreciable extent. The value to the works of the experience thus gained is inestimable, offering, as it does, every opportunity for improvement in design.

To illustrate all the interesting examples of switchgear that were going through the works at the time of our visit is out of the question, but attention may be drawn to the five examples shown in Figs. 10–14. The first of these illustrations shows a large remote electrically-controlled switchboard for the London Power Company; the second a desk control switchboard for 11 kV, 50 kV and 110 kV switchgear, with a single line coloured diagram, for a hydro-electric scheme in New Zealand; the third a 440-volt three-phase switchboard with aluminium panels; the fourth a 16 pillar metal-clad compound-filled switchboard with duplicate bus-bars and selector switches; and the fifth a 6600-volt three-phase switchgear, comprising stone cell work with a duplicate bus-bar system and electrically-operated circuit breakers.

LAST year the consumption of electrical energy in Belgium reached 320 kW-hour per head of population, which compares very favourably with Germany, 250 kW-hour; France, 248 kW-hour; England, 200 kW-hour; Italy, 197 kW-hour; and Holland, 134 kW-hour; Switzerland leading in Europe with 700 kW-hour. Of the 2670 Belgian communities, 2010 are now connected to the mains of the central stations, and when the remaining 660 small communities, with an average population of 1000 each, will also have been connected, the whole of the country will be electrified. Twenty-three central stations serving about 75 per cent. of the country, have an average generating capacity of 32,000 kW, as against 5000 kW in 1910. The total amount of energy generated last year exceeded 3,000,000,000 kW-hours, 90 per cent. of the energy being for industrial purposes, 9 per cent. for domestic purposes, and 1 per cent. for public lighting.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TENDENCIES IN STEAM TURBINE DEVELOPMENT.

SIR,—When Mr. H. L. Guy delivered the above paper on January 31st last, before the N.W. Branch of the Institution of Mechanical Engineers at Manchester, he referred to the fact that:—"With increase of steam temperature the coefficient of elasticity, with Young's modulus of steel, decreased as the temperature rose, and the critical speed of any part was affected by that decrease in elasticity. It was customary to design turbine shafts so that their critical speed was at least 25 per cent. above that of the running speed. If that was desired, when the temperature was 900 deg. Fah., the critical speed would have to be 36 per cent. above the running speed at 60 deg. Fah."

Professor B. P. Haigh, D.Sc., of the Royal Naval College, Greenwich, in an article he wrote entitled "The Static Balancing of Rotors," published in THE ENGINEER of March 23rd and 30th, 1928, very clearly brought out the fact that "The customary 25 per cent. margin between running speed and critical speed is required, not only to cover any uncertainty in the calculations of the true critical speed, but also an allowance for imperfections in balancing."

It is, of course, well appreciated by designers that the centrifugal loads on a turbine's bearings depend on the ratio between the running speed and the critical speed. As Dr. Haigh further pointed out, "The more ideal the balancing is and consequently the more the excentricity due to unbalance can be reduced the closer a rotor can be designed to run near its critical speed. This is so because any initial excentricity of the rotor is liable to magnification by the elastic flexure of the shaft. In any ordinary rotor the whirling speed at which dynamic unbalance first makes itself really evident always lies far above the better-known critical speed at which static unbalance produces dangerous effects, although dynamic unbalance does not. In rotors that have to run at 70 to 80 per cent. of the well-known critical speed, static unbalance is liable to be magnified while dynamic unbalance is not. Great care should thus be taken to eliminate static unbalance from such rotors, but dynamic unbalance may be often disregarded. If, then, any initial unbalance can be completely eliminated, it will be possible to design shafts in which the 'primary' critical whirling speed does not lie 20 per cent., but a less margin above their running speed. On the other hand, a larger margin may be necessary if the state of static balance is unsatisfactory."

It follows from the above that for turbine rotors working at the high steam temperatures referred to by Mr. Guy the necessity for ensuring most accurate static balance would seem of vital importance, as it would enable an appreciably smaller margin than the 36 per cent. mentioned between the running and the critical speed to be allowed for, which would have its advantageous effect on the rotor's design, in that it would probably enable its shaft dimensions to be reduced, weight and cost saved, while the chances of vibration would be appreciably lessened and the dependability of operation consequently increased.

Blade vibration trouble is likewise liable to be intensified on highly stressed material and rise in temperature with its attendant drop in elasticity modulus of the material, leading to reduction in the allowable stresses, may tend to make these matters more acute.

Here, again, if a reduction between the ratio of running speed to critical speed can be obtained by means of much closer static balancing, a smoother motion of the rotor will result, the periphery of which carries the blades and the tendency to set up a reed-like flutter in the latter will consequently be overcome.

To counteract blade vibrations caused from blade sections being corroded or eroded, leading to their ultimate collapse, other measures are required, either preventive, that is, by using special resistive materials, or corrective, by keeping the feed water acid, oil and air free and softening it.

Where the latter cause is always more or less present it offers a reason the more why turbine constructors should take every available precaution to satisfy themselves that turbine rotors are initially as free as possible from vibration.

Constructors of high-speed rotors in general would, therefore, be well advised to bear in mind that only close static balance will enable them to eliminate or reduce to well within safe operating limits the cause of the dangerous magnification of initial excentricity at the primary whirling speed.

There seems to be no doubt that this has been at the root of many, if not most, of the troubles encountered; hence it would seem imperative that every precaution be taken to eliminate its initial cause if smooth and dependable operation is to be sought after in future installations.

In view of this the following observations may not be out of place. It would appear that the vital importance of accurate static balancing has as yet not received that appreciation generally which it without a doubt deserves.

Great stress has been laid by many on the dangers of couple effects in rotating bodies, in consequence of which elaborate and often expensive dynamic balancing equipment has been resorted to.

Professor Haigh has pointed out that "In many of these machines the rotor shaft is made to move in a plane motion instead of conical motion, as it would naturally want to do. As a result, in such machines the rotors always show a secondary critical speed which is usually not far above the primary. To make use of such a machine to study dynamic balance it is necessary to run through the lower primary critical speed up to the secondary; and if the two speeds are nearly alike, it is particularly difficult to interpret the actions observed, because the two actions then intermingle. In conical whirling as occurs in practice, however, the secondary critical speed is absent or very much higher than the primary. Conditions in such machines are, therefore, artificial and intentionally such as to exaggerate the importance of dynamic unbalance. The observer should not carry away the impression that both actions necessarily occur at correspondingly higher speeds in practice. Rotors may be divided into two main groups: those in which dynamic balancing is really desirable, and those in which dynamic balancing is an unnecessary refinement. The second group is, in fact, much the larger. It appears desirable that all important rotors should be balanced statically, and that only a few should go on to the more expensive second stage of dynamic balancing. The utility of this basis of division is more apparent when we reflect that very great advantages are gained at small expense by static balancing, and that the advantage gained at great expense by dynamic balancing is often only very slight indeed."

These proven facts are relevant at present and would seem to deserve the closest attention of turbine constructors now that higher steam temperatures and operating pressures are becoming more general practice at increased operating speeds, so as to obtain improved efficiencies with smaller-sized turbine units for a given service.

W. HAMILTON MARTIN.

London, August 22nd.

THE EDUCATION AND TRAINING OF ENGINEERS

SIR,—I have read with interest the letter under the above heading in your issue of June 7th, 1929, and being one of those either fortunate, or unfortunate, as the case may be, whom your correspondent describes as having had a training which the normal engineer cannot afford, I feel that I am in some degree competent to voice some opinions.

While I agree with your correspondent in so far that the trained engineer holds neither the financial nor social prospects of the medical man, I contend that the embryo engineer is not wrong in obtaining a training similar to that indicated in the letter—*i.e.*, school until seventeen, then three or four years of apprenticeship, and a three-year course at a college. After all, the Institution of Mechanical Engineers has definitely laid down what shall constitute the training of a mechanical engineer, and, to a large extent, calls for the course of training set forth above; except, perhaps, that the technical part of the A.M.I., Mech. E. examination can well be taken without the necessity of a full time college course.

It is my opinion that the source of the difficulty lies not in the accepted training, but rather in the fact that we as a profession are wholly unprotected by any powerful organisation, which can compare with the British Medical Association. Herein lies the reason why the young mechanical engineer, while being fully trained, often has to accept a position considerably below his mental capability. The profession is flooded. That is a fact that cannot well be disguised, and I do not consider the position will greatly improve until engineers as a whole lay down definitely and finally a qualification, the attainment of which will only allow a man to call himself an engineer. Under the present conditions any one, whether trained or not, is entitled to call himself an engineer, and it is not infrequent to find any one, from the man who repairs bicycles or he who drives a locomotive upwards, not only terming himself an engineer but even thinking that he is one.

It is this which is responsible for the profession not only being flooded, but the social and financial standard is lowered.

S. T. WILLCOX,
Assist. Mech. Engineer, S.I.R.

Golden Rock, August 8th.

THE FAILURE OF AIRCRAFT ENGINES.

SIR,—In your issue of August 23rd, page 205, you say that the failure of the engines of the "Graf Zeppelin," on her attempt to fly across the Atlantic on May 16th, was due to torsional oscillations of the crank shafts. The difficulty, it may interest you to learn, was overcome by substituting Bibby couplings, as described in your issue of July 13th, 1928, to every engine in the airship, in the same way as is now commonly done in similar difficulties.

For the WELLMAN BIBBY CO., LTD.,
J. BIBBY.

London, S.W. 1, August 28th.

THE company engaged in salving the German sunken battleships at Scapa Flow, namely, Cox and Danks, Ltd., is concentrating on the removal of the light cruiser "Bremse" (5000 tons) from Swanbister Beach, on the north side of Scapa Flow, where she lies on her side, to Lyness Pier. Two docks have been towed across Scapa Flow and placed in position alongside the "Bremse" to assist in turning her bottom upwards. The mode of floating the cruiser will be the same as in the case of the larger vessels—namely, by filling her with compressed air and towing her away bottom upwards. Already she is under several pounds air pressure and almost ready for turning. Owing to the awkward position of the vessel inshore, fully one month must elapse before she can be removed. Other squads of workmen are busy preparing large airlocks for the battleship "Prinz Regent Luitpold," which lies in deep water, bottom upwards.

Railway and Road Matters.

THE Carnforth end of the triangle that gives access from the north and from the south to Morecambe is worked from Hest Bank Junction. As a passenger train from Carnforth to Morecambe was passing off the Carlisle–Euston main line at that junction on the evening of August 22nd, some carriages were derailed, but there were no personal injuries.

DURING the first twenty-nine weeks of the present year, the four grouped companies' weekly traffic returns showed, as compared with the corresponding period of 1928, a decrease of £1,534,000 in passenger receipts and of £360,000 in general merchandise. There was, however, an increase of £1,750,000 in coal traffic, so that the net decrease was reduced to £144,000.

IN a letter in *The Times* of August 20th, Mr. R. A. H. Weight records a run during that week with the down "Queen of Scots" Pullman express, which was drawn by an engine of the "Director" class and had a load of 320 tons. It attained, he said, a speed of 90 m.p.h. beyond Hitchin; average, 87 m.p.h. for 3 miles; covered the first 56 miles from King's Cross in as many minutes, and reached Peterborough, 76½ miles, in 74¼ minutes.

WE regret to read of the death on August 18th of Mr. C. de J. Andrewes, who was appointed the chief solicitor to the London and North-Western Railway in 1903, on the early death of Mr. C. H. Mason. Mr. Andrewes retired in 1915, but came back to semi-active work in connection with the Ministry of Transport Act, 1919, and the Railways Act, 1921. We would take advantage of putting this announcement upon record to testify to the courtesy and willingness with which the deceased gentleman was ever ready to assist inquirers with his wide knowledge of railway law.

AN official notice has been issued by the London, Midland and Scottish Railway that on September 23rd "the branch line between Halifax and Stainland" will be closed for passenger traffic. Such a notice is incorrect, inasmuch as the Stainland branch commences at Greetland, which station has 2 miles between it and Halifax. That is the second branch in the same neighbourhood to be closed down as regards passenger traffic, as the Ripponden branch commences at Sowerby Bridge, 2 miles west of Greetland. A third branch to be so closed is the Mansfield and Southwell. That is remarkable in that, as related on page 56 of THE ENGINEER of January 11th last, a considerable portion of that branch has recently been converted from single to double track.

THE Ministry of Transport railway statistics for the month of May have recently been issued as a Stationery Office publication, price 3s. 6d. They show that the number of passenger journeys, when compared with May, 1928, increased by 5·2 per cent.; the receipts from passengers fell, however, by 2·2 per cent. That was due to the increase in passengers being wholly from those travelling at reduced fares. Passenger train mileage rose by 3 per cent., consequent upon the latter feature. Every class of goods traffic was, on the other hand, up in tonnage, but mainly in coal, coke and patent fuel, which traffic rose by 9·31 per cent.; the total increase of tonnage was 6·93 per cent. The receipts from general merchandise had a decrease of 0·66 per cent., but goods traffic receipts generally had a rise of 3·42 per cent. The goods train mileage increased by 3·1 per cent., but the average train load advanced from 124½ to 128¼ tons and the net ton-miles per engine-hour from 440 to 454¼.

THE Board of Trade returns for the six months ended June last show the value of the railway material sent overseas to have been as follows, the corresponding figures for 1928 and 1927 are added in brackets:—Locomotives, £1,544,778 (£2,051,244, £843,804); rails, £1,435,610 (£1,867,502, £1,193,207); carriages, £1,014,162 (£1,499,495, £1,712,491); wagons, £1,281,412 (£1,775,886, £1,091,633); wheels and axles, £203,235 (£465,105, £302,243); tires and axles, £268,969 (£301,591, £266,173); chairs and metal sleepers, £227,131 (£547,010, £534,663); miscellaneous permanent way, £547,770 (£758,519, £759,321); total permanent way, £2,773,628 (£4,013,311, £3,206,976). The weight of the rails exported was 171,917 tons (214,843 tons, 144,494 tons), and of the chairs and metal sleepers, 23,625 tons (55,256 tons, 53,642 tons). During the month of June last locomotives to the value of £252,014 were shipped overseas, which included:—India, £134,784; the Argentine, £76,524; other countries in South America than the Argentine, £18,560. During the same month the value of the rails exported was £180,890, which included:—South Africa, £66,701; the Argentine, £59,339; Straits Settlements, £9099; India, £9004; Portuguese East Africa, £5174.

As recorded in this column on June 14th last, there was on the 9th of that month, a derailment of the rear six coaches of a passenger train of seven carriages at Whitehall Junction, just outside Leeds, Wellington, Station, (London, Midland and Scottish Railway). The accident was inquired into by Colonel Trench, whose report thereon was issued on August 22nd. There are four lines of way where the mishap occurred and the train was travelling on the down fast line. North of that line was the up fast, and immediately to the south was the up slow and then the down slow. There was a crossover junction from the up slow to the up fast, which intersected the down fast line, and it was at the point of intersection that the derailment occurred. After the accident the double chair at the throat of the V crossing in the northern rail of the down fast line was found broken, but it is not proved that that was the cause of the trouble. The theory of the officers of the railway was that a key fell out from the chair, and that that led to the breakage of the chair; conversely, had the chair been broken, the key would have been loosened. On the other hand, no key was found missing when the line was inspected 20 minutes after the derailment. Colonel Trench says, however, that he "cannot imagine that after the fracture of the chair the key would have remained in position under the vibration of a number of wheels, and this leads me to suspect that the key must have been replaced after the accident." An improvement in the lay-out of the crossing, though difficult to achieve, should be attempted, and "the additional strength of the new British standard design for crossings would be especially desirable at this point."

Notes and Memoranda.

AN article which recently appeared in *World Power* discusses the costs of a modern type of power station. The author considers that a station having a capacity of 200,000 kW capacity can now be built for less than £13 per kW. The fuel costs at the bus-bars of such a station would be 0·125d. per kWh. The annual fuel bill at 50 per cent. load factor would be £450,000, or 18 per cent. of the total capital cost of the station, using coal at 15s. per ton. The operating costs would be 7·7 per cent. of the fuel costs, and repairs and maintenance 10 per cent. of the fuel costs. The number of men required would be 1·2 per 1000 kW installed.

THE usefulness of a telegraph line can be greatly enhanced if arrangements are made to transmit several messages simultaneously over one pair of wires. This can be done by sending each of the messages with a different alternating-current frequency and resolving them at the receiving end by selective apparatus. A system is described in a German publication, whereby a small special generator furnishes ten different frequencies between 375 and 1725 cycles, each 150 cycles above the next. The output of each frequency band is 5 watts, which is sufficient to operate several systems. It is claimed that such a machine has decided advantages over a system in which the various frequencies are produced by valves.

THE extent to which electric steel has gradually replaced crucible steel in the United States, states an American contemporary, is emphasised by a study of recent statistics. Since 1914 the tendency of crucible steel ingot has been generally downward, while that of electric steel has been upward. From 1914 to 1926 crucible steel declined about 85 per cent. In electric steel the spread between 1914 and 1926 has been one of over 206·5 per cent. increase. The war output of crucible steel in 1917 was the peak for that class of steel since 1912, while for electric steel ingots the war production of 403,068 tons in 1918 has been surpassed since, the high point being the output of 453,692 tons last year. From 1914 to 1928 the decline in crucible steel output has been about 92 per cent., while in electric the spread for the fourteen-year period has been an increase over 282·5 per cent.

A NEW electric heating unit, designed especially for warming the engine oil of aircraft to facilitate quick starting, especially in cold weather, is announced by the American General Electric Company. The unit will operate from the local electric lighting circuit in the hangar. When aeroplanes are stored in unheated hangars it has been customary during cold spells to drain the lubricating oil from the oil tank after flying operations in the evening and to preheat the oil in the morning. The new electric heating unit consists of two 110-volt, 375-watt heating units, conveniently shaped to fit into the conventional aircraft oil tank by insertion through the filter cap; three degrees of heat are provided. The units can be operated in series for low heat intensity, they can be used as a single unit for intermediate intensity, and they can be operated in parallel for high intensity. The corresponding consumption are 187, 375, and 750 watts respectively at 110 volts.

FOR some time, states the *Electrical Times*, experiments and research have been proceeding with a view to discovering some means of rendering permanent the pictures received by the "Fultograph" on paper treated with starch and potassium iodide. It is well known that such pictures may last for several months if the paper is dried out quickly as soon as it has been removed from the cylinder and is afterwards not unduly exposed to strong light; but until a short time ago no means could be found of fixing them permanently. The credit for the discovery of the method goes to an amateur, Dr. Alfred J. H. Iles, of Taunton; after a great deal of experimental work he discovered that the key to the problem was to be found in alum. After reception the picture is laid face downwards in a dish containing a solution of alum and ordinary tap water. One teaspoonful of alum to a pint of water is a satisfactory mixture. The picture, it is said, then becomes as permanent as a photographic plate or print after fixing.

THE introduction of a new metal known as "Konel," which is credited with being much stronger than other metals at high temperatures, and which is suitable for use in the moving parts of internal combustion engines and other extremely hot places, has been announced by the Westinghouse Electric and Manufacturing Company, of Pittsburgh. The metal has been patented. Originally developed in the Westinghouse Company's Research Laboratories as a substitute for platinum in the manufacture of filaments for wireless valves, the new metal was discovered to be harder to forge than steel, and to be very tough at high temperatures, when most metals lose their strength. The inventor is said to be Dr. E. F. Lowry, a graduate of Ohio State University. The cost is given as being only a few dollars a pound. Life of Konel valve filaments is reported to be approximately ten times longer than that of other filaments. Valves with filaments made of it are operated at a temperature 175 deg. colder than valves with platinum filaments, but give the same emission.

AN enormous amount of research into the origin and nature of atmospherics has been done in recent years by the radio research station at Slough, and the station is now to make use of an entirely novel method of recording them. The Royal Meteorological Society has arranged with the B.B.C. for special transmissions after the normal picture programmes and they will be picked up by Fultograph receivers installed for the purpose at recording stations in various parts of Europe. The transmissions will not take the form of pictures; instead there will be sent out a series of straight lines, both horizontal and vertical, forming a grid or network. When an atmospheric occurs, deformation of the straight lines will take place to an extent depending upon the intensity of the interference. It is hoped that by this means it may be possible to make records which will afford valuable data for research into the intensity, duration, and origin of individual atmospherics. Since the drums of all receiving apparatus, wherever situated, will be synchronised, it will be possible, by comparing the results obtained in different places, to determine the range at which an individual atmospheric can cause interference and the intensity of such interference in different localities.

Miscellanea.

A TABLET is being erected in the Tower of London to the memory of the Rev. Alexander John Forsyth, M.A., LL.D., the inventor of the percussion lock for small arms, and it is hoped that the work will be completed in time for the unveiling ceremony in October.

THE total production of bituminous coal in the United States during the week ended July 20th, including coal coked at the mines, is estimated at 9,198,000 tons. This is a decrease of 234,000 tons from the output in the preceding week. The total production of Pennsylvania anthracite during the week ended July 20th is estimated at 1,062,000 net tons, as against 1,068,000 tons in the preceding week.

IN the course of a report just issued of a preliminary inquiry into the explosion of an economiser at Wrigley Head Mill, Failsworth, which took place on March 6th, it is stated that the explosion, in the opinion of the Inspector, was due to the flue gases being allowed to pass through the economiser while no circulation of water in the tubes was taking place. The tubes being in a deteriorated condition and subject to severe temperature stresses, were unable to withstand the pressure generated, which may have been less than the working pressure.

A NEW company, Skyways, Ltd., of Toronto, is establishing an air port about four miles west of Toronto, with all the latest devices for handling aeroplanes. It will be the first airport in Canada to be completely equipped as a night landing field, including the Neon flood and beacon lights, similar to those used at the largest ports in Europe and the United States. Runways 1800ft. long, which will be sufficient to allow tri-motored machines to alight and take off in safety, are being built. There will be a general repair shop for the maintenance and care of all types of machines under the direct supervision of licensed air engineers.

THE great increase in the number of motor omnibuses running in the Nice district has so reduced the traffic on the tramways that many of them are now being run at a loss. As a result, an agreement has recently been arrived at between the General Council of the Alpes Maritimes Department and the Compagnie des Tramways de Nice et du Littoral, to discontinue running trams over eight routes and to cancel the construction of two lines, a concession for which was granted some time ago. The tramway company is to receive an indemnity of 2½ million francs—about £20,000—and is to be authorised to run motor omnibuses in place of trams.

THE Belfast shipyard stoppage, which followed a wages demand by the members of the Amalgamated Society of Woodworkers, has now reached serious proportions, and at the present there are about 4000 men idle. The dispute has now affected other branches of the industry, and it is estimated that unless a settlement is reached within the next fortnight, about 8000 men will be thrown out of work, and there is a danger of the trouble spreading to other shipyards. In view of the seriousness of the position, the Engineering and Shipbuilding Trades Federation have decided, on behalf of all the trades concerned, to offer to bring the two sides together in an effort to reach an amicable settlement.

WE hear that Mr. R. Borlase Matthews, the promoter of the Lincolnshire rural electrification scheme, has now lodged an application for power to supply an adjoining area in the counties of Leicestershire, Rutlandshire, Northamptonshire and the Soke of Peterborough, the granting of which would bring his total area up to 1833 square miles, serving a population of 193,330 persons. The scheme is of interest, not only because it is the first rural scheme based upon the anticipation of the operation of the national "grid," but also because it proposes to bring electricity to the door of all but the most isolated dwellings throughout the area, instead of catering almost exclusively for urban and industrial demands. In this scheme he has an excellent opportunity to demonstrate the rightness of his contention that the rural load, properly cultivated, can be met at a price which is mutually satisfactory to the distributor and the consumer.

FOLLOWING the recent deputation from the Shipowners' Parliamentary Committee to the Lord Privy Seal and the suggestions then made by Mr. J. H. Thomas in his capacity as Minister of Employment, a meeting has been held at the Chamber of Shipping of the Port Facilities Committee of the Chamber of Shipping. This Committee, which represents shipowners and manufacturing and trading interests, issued a report in 1924 containing a wide range of recommendations for improvements in port facilities. The Committee recognised that any proposals in connection with the Government schemes for relief of unemployment which may affect ports and harbours must be put forward to the Government on the primary responsibility of the Port Authorities, but it felt that its present examination might well contribute to the general consideration of schemes for improvement of port facilities, and with this object it appointed two sub-committees to examine the position—one in regard to the main oversea ports of the country, the other in regard to small ports.

FROM the report on the work during 1928 of the Mining Research Laboratory, University of Birmingham, we note that an investigation has been made into the possibility of partial hydrogenation for the purpose of converting coal into a material capable of being briquetted by means of elevated temperature and high pressure without the aid of an added binder. Briquettes produced from certain coals by heat and pressure treatment have shown, the report says, that the partially hydrogenated product would stand more than twice the compression required to fracture the untreated coal. A variety of coals have been tested in this way. The briquetting of the products of hydrogenation was mentioned in the annual report for 1925 as being part of the programme of research, and the results of this work were thought to be of sufficient value to cover by patent for the British Colliery Owners' Research Association. A recently-published patent under the names of Lander, Sinnatt and King (all of the Fuel Research Division of the Department of Scientific and Industrial Research), has, however, shown that the production in the coal itself of a suitable binder has been in the minds of these investigators.

NORTHERN PACIFIC RAILWAY—NEW DYNAMOMETER CAR

(*For description see page 230*)

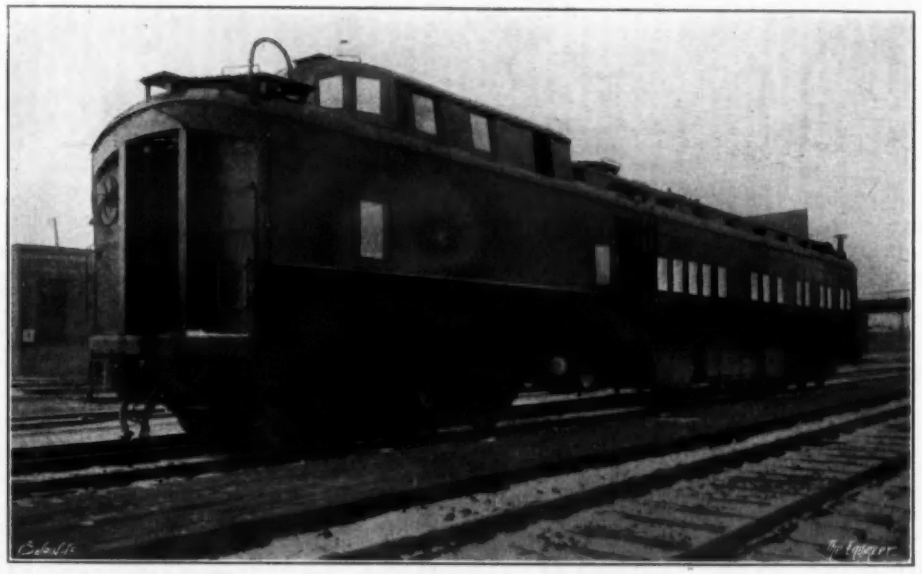


FIG. 1—GENERAL VIEW OF CAR

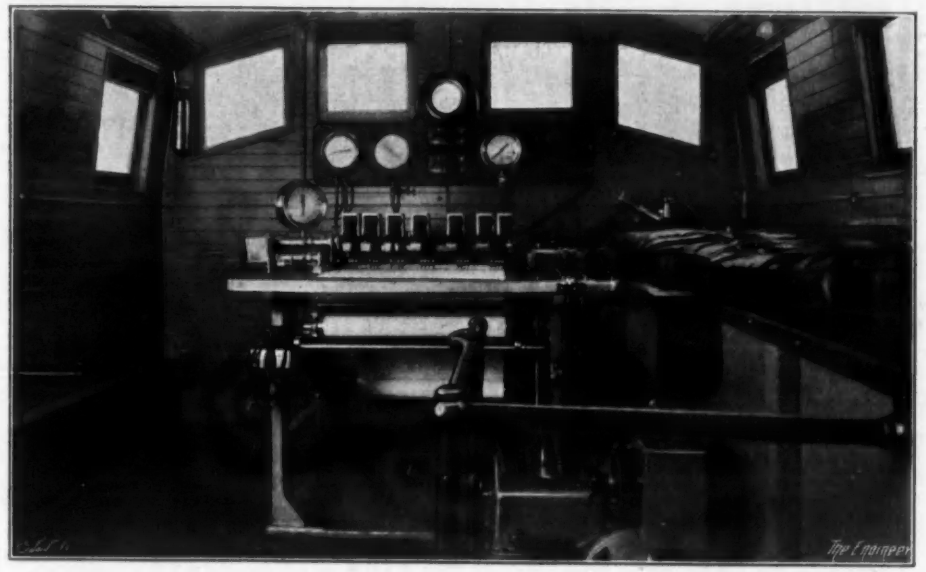


FIG. 2—CHRONOGRAPH AND OBSERVATION CUPOLA

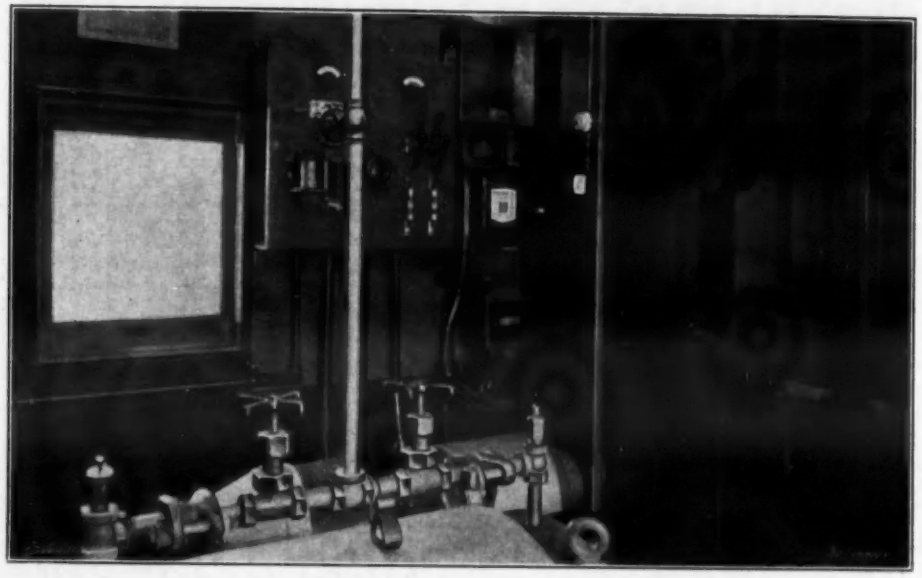


FIG. 3—WEIGHING HEAD OF DYNAMOMETER

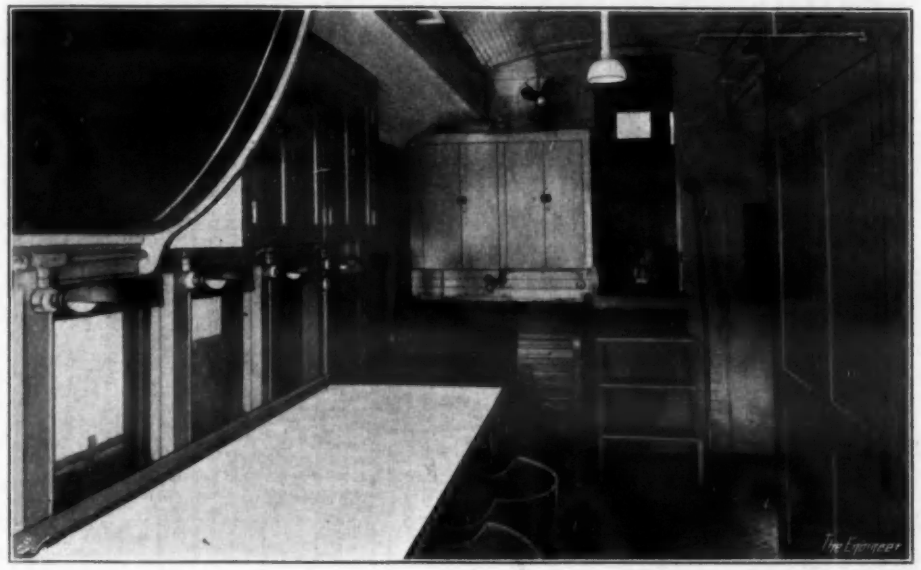


FIG. 4—WORK ROOM AND STAIRS TO CUPOLA

The Engineer

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The Metallurgist.

THE AUGUST NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

DEATH.

On August 28th, at Normandy Lodge, Vanbrugh Park-road West, Blackheath, S.E. 3, THOMAS SYDNEY FLETCHER GIBSON, M. Inst. C.E., Chief Civil Engineer, South Metropolitan Gas Company, aged fifty-nine.

THE ENGINEER.

AUGUST 30, 1929.

The Electrification of Railways.

THERE is a good deal of misconception, not only in the public mind, but even among railwaymen, as to the advantages of the conversion of railways from steam operation to electric traction. During the General Election all the parties declared their willingness to assist the railways, and one of the directions in which that assistance was promised was electrification. In that relation Mr. J. G. H. Warren rendered useful service in sending to *The Times* a quotation from Lord Monkswell's "Railways" in Benn's Sixpenny Library. No one would think of labelling Lord Monkswell as an advocate for the railway companies, and therefore what he has to say about electrification may be accepted as without prejudice. The quotation in question begins by the remark that "Main line electrification, except in countries like Switzerland, where there is no coal and immense water power, may be regarded, for the present at least, as definitely at a standstill." Lord Monkswell then proceeded to say that "The example of France very clearly shows the difficulties and limitations of electrification." Schemes have been passed for the conversion of some 6000 miles of railway on the P.L.M., Paris-Orleans and Midi systems, but "At the present time perhaps half of the Midi's programme has been carried out, not more than a quarter of that of the Paris-Orleans, and not more than a tenth of that of the P.L.M., and it has been found that the cost of what has been completed is so great that there is definitely no economy and probably considerable loss." Mr. Warren added in his letter that during the visit of French railway engineers to this country in May last he obtained confirmation generally of what Lord Monkswell had said.

The policy of conversion to electric traction cannot, however, be dealt with in a general way. There appear to be three classes of traffic for which electrification may be suitable. The first is that within suburban areas, as represented in our own country by London, Liverpool, Manchester and Newcastle-on-Tyne; the second is general electrification on the main line, as in France, Italy and Switzerland; whilst the third is the electrical operation of goods trains only, as on the London and North-Eastern Newport-Shildon line, with a view to the more economical working of goods traffic. This last, we may say in passing, is a field which has, perhaps, not been sufficiently explored. Besides the difficulty of dealing with the policy of electrification in a general way, the conditions of one country cannot be judged by those of another. That fact will at once be recognised when it is remembered that whilst the southern and central areas of France and the whole of Italy and Switzerland have no coal, but have a good supply of water power, the exact contrary is the case in Great Britain. Again, whilst it is undoubtedly true that the results of the changes on the main lines in France have been disappointing, that may not be so with the electrification of the suburban lines of the State railway system in Paris. At the end of 1927 it was reported that the Austrian State Railways had decided to go no further with a scheme of electrification because it had been found that already electrified portions of the system were working at a financial disadvantage as compared with the steam-operated section. Going further afield we have, in the last annual report of the South African Railways, the records of three conversions to electric traction. Of the Monument-Sea Point line, just outside Cape Town, it is said that the railway, never a financial success, reflects under present conditions a deficit in working even larger than under steam operation. That is accounted for principally by the additional charges to be met on the heavy capital cost of the electrical equipment and the high cost of electric power; the latter alone almost equals the total earnings of the line. The fares were lowered, but since there was no consequent increase in traffic they have been raised again. The Cape Town-Simonstown electrification has given the public a more attractive and expeditious form of transport, which should result, it is hoped, in the recovery, to some extent at least, of the traffic lost. But, the report proceeds to say, "Even were this to happen, there do not appear to be any grounds for anticipating that the receipts will, for many years to come, cover the extra capital charges and operating costs entailed by electrification, and consequently the annual loss on this section is likely to be heavy." These, it should be noted, are suburban lines, and it is admitted that both are run at a loss. Of main line electrification, *i.e.*, that in Natal, it is observed that experience with the system shows that though it is undoubtedly an extremely efficient means of transport, the capital outlay is so enormous that only under the most favourable conditions of intensive traffic is there any prospect of meeting the additional cost in interest and other charges which the adoption of electric traction entails. The general manager of the South African Railways, who signs the report in question, adds that he had been pressed to proceed with the electrification of the Durban-Pietermaritzburg section, but the heavy capital outlay and the addition to the working costs make it impossible for him to recommend any extension at present. He appreciated the need for the more expeditious transit of traffic between the points named, but that could, in his opinion, be as efficiently and more economically obtained under present conditions through the medium of steam locomotives of high tractive power and by doubling the line where necessary.

Despite these adverse reports the policy of converting railways from steam operation to electric traction must not be lightly condemned; in fact, it may almost be said that, in the long run and all things considered, the electrification of the suburban services in busy areas pays. The results must not be judged only by the number of passengers carried. Times have changed since Sir John Aspinall, at the Washington International Railway Congress in 1905, when discussing the reports by Messieurs Paul Dubois and Ernest Gerard on electric traction, said that the Lancashire and Yorkshire did not convert the Liverpool-Southport line to save money, but to make money.

That is not so much the case to-day. The capital charges are very much higher, current is still dear, maintenance of rolling stock and of track is much greater, and trainmen's wages are double what they were. It may be retorted that costs in steam working have also been increased, but, generally, each item therein is lower rated than in electrical operation and the net increase is therefore comparatively less. It is thus more difficult to-day "to make money." The advantages of electrification now lie more in what it saves in comparison with steam working, in such matters, for example, as the number of trainmen, time in stations for reversing, engine turntables and pits, reduced occupancy of the main line as a result of quicker acceleration, &c. These benefits, too, have a cumulative effect; they also benefit other services, and the results therein cannot be measured by figures. But the greatest benefit of electrical operation of suburban services lies in the power it gives the railways of meeting the losses arising from road transport competition. No company has suffered more in that direction than the Southern, but the 6½ million more passengers carried by the electric services in 1928 as compared with 1927 resulted in that company suffering a drop of only £160,000 in third-class receipts, as against a loss of £400,000 on the London, Midland and Scottish and of £500,000 on the London and North-Eastern.

Foreign Industries and Trade.

A RECOVERY of foreign trade is a matter of primary importance to British manufacturers. Nothing which affects the future business relations with other countries can fail to interest them. When trade has been subjected to such an upheaval as that caused by the financial crisis all over the Continent, it can only settle down again on a normal basis by a process of adjustment. That adjustment will necessarily be slow and very difficult to accomplish, and when, finally, trade emerges from the melting-pot stage, the conditions will be found quite different from what they were formerly. The object of British manufacturers now is to adapt themselves as closely as possible to the constantly changing conditions. And the conditions will continue to change until a financial adjustment on the Continent enables all countries to see exactly where they stand. It is only then that it will be possible to take stock of the future. Before the lessons of the war brought home to foreign countries the desirability of making themselves as self-supporting as possible, and of utilising the extensive plants that were laid down during the period of hostilities, the art of selling in those countries was a simple matter. There was not the same competition as now. There were countries that produced goods of better quality and more cheaply than others, and those goods were bought because any attempt to protect unduly competitive home industries would have been detrimental to the interests of consumers and of the national welfare. The representatives of British firms were able to secure orders through ordinary business connections. British goods sold on their reputation. The conditions nowadays have completely changed. Industrial organisation on the Continent has made such enormous progress that there is hardly a class of goods which foreign manufacturers do not produce, or cannot produce if there is a demand for them. They are favoured by tariffs, and, more especially, by lower values arising from depreciated currencies, which, however, are now being stabilised more or less on a gold basis, but although values in France and some other countries are advancing, and will continue to advance, they are yet still below the level of those in Great Britain. They are lower because wages have not risen to the same extent as in this country, and the values of commodities are regulated largely by the wages paid. Unless the higher wages are justified by an increased and more economical production, their purchasing value may be less than the lower wages paid in other countries where the living cost is less. This higher purchasing power of lower wages is one reason for the industrial development which has taken place on the Continent. It is true that the standard of living abroad is below the standard in Great Britain, but it is far above what it was formerly. This improvement is due mainly to cheaper production arising from the modern equipment of factories which have sprung up during the past ten years, and also to the keenness with which continental manufacturers are following progress abroad and are profiting from any advance in methods that may be adapted to their own industries. This should be kept in mind when considering how best to do business in markets which aim at producing all they can themselves.

The industrial conditions in Europe have so far changed that the markets in which all classes of foreign goods can be sold have been narrowed down, and the competition for that business has grown through the necessity of new manufacturing countries finding an outlet for their surplus production. It is becoming increasingly evident to foreign makers that they cannot develop their industries by relying entirely upon the home demand. By keeping the production within those limits costs cannot be reduced sufficiently to cheapen goods. Each industry, therefore, looks immediately to an expansion of trade abroad which will enable it to manufacture goods in larger quantities and at lower cost, and, by selling more cheaply, increase the home consumption. The general policy is to monopolise and develop home markets as a means of extending business abroad. The result is that the industrial conditions have become extremely arduous, and, so long as foreign industries are protected in their own markets, the increasing production which that implies accentuates competition for trade abroad, and necessitates new methods of distribution. They are not new in the sense that they are already employed by American manufacturers, who have, for example, established factories for the production of motor cars and agricultural machinery in protected countries that are conveniently situated for exporting to other markets, while in Germany two motor car firms have been absorbed by American interests. But they have introduced new features in European trade, and in Germany and France manufacturers are adopting a systematic organisation for reducing costs and developing foreign trade. So far, the returns of foreign trade do not show that these efforts have met with any particular success. Nevertheless, it is clear that the industrial interests which have been growing on the Continent during the past ten years are opposed to any change in economic conditions that may weaken their situation in home markets. They cannot come to arrangements with foreign countries when they refuse to facilitate the importation of foreign goods. There can be no illusion about the fate of the proposal to create a European economic federation, which will necessarily involve the sacrifice of new and more or less artificially created industries. So long as a home trade will keep industries alive without increasing selling costs unduly, there will be a strong opposition to any reduction of protective tariffs. It is only in the event of an intensive production in face of a more moderately increasing consumption provoking a crisis that the situation will be more favourable to the carrying out of a policy of reciprocal concessions which will benefit trade as a whole.

Even though trade should undergo an evolution towards freer international exchanges, it is clear that the conditions of competition will remain much the same as they are now. One factor of the situation in many countries is the priority of price over quality; but, notwithstanding the importance attached to price, there are many who will pay more for goods bearing names and reputations that inspire confidence. There are two ways by which British makers can hope to compete for foreign trade. One is to maintain quality and the other to sell at prices that are not regarded as prohibitive. The British have lost a lot of ground through the general impression that their goods are too expensive. That impression arose at the time of the monetary depreciation, and nothing has been done since then to remove an idea which, in some cases at least, is exaggerated. German manufacturers have secured an enormous advantage in French and other markets by supplying a considerable amount of goods on account of reparations. This has firmly established them, and they are offering all kinds of goods through capable agents. They aim more particularly at supplying special labour-saving machines of greater efficiency than those manufactured in the countries in which they are offered. Apart from the business results obtainable, this offer of new and improved machines creates a reputation which stands a country in good stead in its relations with foreign buyers. British manufacturers are not behindhand in the designing and building of machines which will effect greater economies in production, but they must be kept to the fore in foreign markets if they are to maintain the British reputation. The higher the reputation, the better are the chances of doing business, and, in the present stage of industrial evolution, there appear to be no other ways of securing business than to maintain quality and secure an irreproachable reputation which will induce foreign buyers to apply to them when they cannot find what they want in their own markets. The point to be emphasised is that there was never so great a continental production of machines and other engineering productions as now, and as all countries are looking to new markets, business can only be obtained by a national reputation for efficiency and good workmanship, backed by a sound organisation for selling at prices foreign customers will pay. The British manufacturing supremacy succumbed to price during the period of financial depression abroad, and since then British foreign trade has been kept in check by the development of foreign industries protected by tariffs and by the German advance through the supply of reparation machines and material to France and other countries. Increasing production costs on the Continent seem to bring us nearer to a turning point when British makers will have a chance to recover some of their foreign trade.

Literature.

Textbook of Ordnance and Gunnery. By Lieutenant-Colonel EARL MCFARLAND. London: Chapman and Hall, Ltd. Price 32s. 6d. 1929.

THIS volume by Colonel McFarland, Professor of Ordnance and Gunnery at West Point Military Academy, will be welcomed by the ordnance engineer. The author states, however, that it is not intended for his use, but is planned for the instruction of the officer of the line and the general student of military affairs. It follows, after twelve years, the excellent work by Colonel Tschappat, and, as the author explains, much of the present work is taken from Tschappat's book. Including a copious index, the present work comprises 625 pages, against 705 covered by Tschappat; this is achieved by adopting slightly smaller type and by omitting a large amount of theory on internal and external ballistics. Quite a lot of new matter has been added, including a short chapter on mechanisation and also four pages of the chronological development of ordnance. We cannot help comparing, adversely, the rough engravings in the pre-war English "Textbook of Gunnery" with the fine illustrations in this book and its two predecessors.

After a general explanation of the manufacture and the characteristics of smokeless powder and other explosives for the United States Army, and the stability tests made during their manufacture and subsequently during service, the theory of explosives is dealt with, building up from thermo-chemical data the temperature of explosion and potential of propellants. From a chemical point of view this is, of course, important, but whether it is of much interest to the soldier or the ordnance engineer is doubtful, because, whatever theory dictates, the suitability of a propellant or explosive depends entirely on the results of practical experience.

Chapter III. gives some interesting information regarding the growth of the nitrogen requirements in the United States.

Dealing with internal ballistics, Colonel McFarland follows the lead given in the United States textbook "Naval Ordnance," 1921, and adopts Le Duc's assumption that the velocity travel curve is closely related to a hyperbola, the general equation of which is $v = \frac{a\,u}{b+u}$, where v is the velocity, u the shot travel, while a and b, although called constants, really depend on the characteristics of the gun. These formulæ are largely empirical and do not take into account the engraving or friction of the driving band. Working on the above-named assumption, however, by the ordinary dynamical methods and introducing a factor to account for the resistances, the equation obtained for the maximum pressure $P = \frac{4{\cdot}48\ a^2\ W}{27\ A\ b\ g}$. Again, from the result of experimental firings it is found that

$$a = 6823 \left(\frac{\omega}{W}\right)^{\frac{1}{3}} \Delta^{\frac{1}{12}}$$

$$\text{and} \quad b = \beta \left(1 - \frac{\Delta}{\delta}\right) \left(\frac{S}{W}\right)^{\frac{1}{3}}$$

where A is the cross sectional area of the bore,
g the force of gravity,
S the capacity of the chamber in cubic inches,
W the weight in pounds of the projectile,
ω the weight in pounds of the charge,
β a powder constant,
Δ the gravimetric density of the charge, and
δ the specific gravity of the powder.

We have gone into this somewhat minutely because two approximate rules—pages 68, 69 and 74—are based on the equation for maximum pressure, viz.:—

(1) The velocity varies inversely as the square root of the weight of the projectile.

(2) Maximum pressures are directly proportional to the weight of the projectile.

Rule (1) assumes that the energy is constant for any particular charge, and for small variations only in the weight of the projectile the rule is sufficiently approximate. It is well known, however, that the

heavier the projectile is the greater will be the energy developed from any given charge.

As regards (2), it will be seen that, if we insert in the equation for P the values of *a* and *b*, putting M for the total value of the constants for any particular gun, then

$$P = M \frac{\omega W^{\frac{2}{3}}}{\left(1 - \frac{\Delta}{\delta}\right) S^{\frac{1}{2}}}$$

From this it appears that $P \propto W^{\frac{2}{3}}$, and not as stated in the rule. With Sarrau's formula $P \propto W^{0.5}$, while Hardcastle and Hezlet—the *Journal of the Royal Artillery*, Vol. XLII., Nos 7 and 8, and Vol. XLIV., No. 3—give as their experience $P \propto W^{0.6}$.

Among the proving ground instruments mentioned is the solenoid chronograph and the Piezo-electric pressure gauge, both well known in England; the last-named was suggested by Sir J. J. Thomson during the war.

The solenoid chronograph seems to be gaining in favour owing to its precision and its suitability for taking velocities of guns at high degrees of elevation; it requires skilled attention, and, as the record is a photographic strip on a cylindrical drum 5ft. in circumference, the results can only be ascertained some time after firing. Similar remarks apply to the Piezo-electric pressure gauge, so that these two instruments of precision are not at present suitable for the rapid determination of velocities and pressures necessary in the every-day routine of the proof ground. It is unlikely that they will supplant the ordinary crusher gauge and Boulengé chronograph; both are acknowledged to give sufficiently accurate results for general purposes, and the results can be ascertained within a minute or two of the actual firing.

Chapter VI. gives an excellent general description of the properties and manufacture of steel, from which it seems clear that basic steel is employed for gun manufacture for the United States Army, but in Tschappat's edition it is not clear whether acid or basic steel is employed; perhaps either may be used so long as the tests stipulated are obtained. In the Naval Service, according to "Naval Ordnance," 1921, it is definitely stated that acid and electric steels are used for naval guns.

The chapter on "Strains and Stresses in Built-up Guns" is the same as in Tschappat's book, but a new section has been added on "Manufacture of Guns by the Cold Working Process," viz., the process now known in England by the French name of "Autofrettage." Unfortunately, too little is said on this important subject. As a matter of fact, this process is by no means new; under various guises it has been employed, though not continuously, in certain countries over the last half-century. For instance, about 1875 Von Uchatius made bronze guns for the Austrian army by casting them around a cold core of copper and so compressing the interior; subsequently he forced a tapered mandril through the bore, thereby also compressing the interior layers of metal and naturally putting the exterior into tension when the gun is at rest, which is precisely what is aimed at in "auto-frettage." Then, again, somewhere about 1910, Professor John Perry proposed a method of making steel guns from a single forging by over-straining the interior by means of internal hydraulic pressure. He published on March 12th, 1915, in *Engineering* his method and the theory on which he based his calculations. A great deal of investigation on the subject has been made in England during the past ten years. It is understood that, in the United States, formulæ have been adopted based on the theory put forward by Captain Duguet, of the French Artillery, who published in 1884 in the *Revue d'Artillerie*, and subsequently in book form, his theories on gun construction, but presumably without any intention of actually utilising these for overstraining the interior layers of guns.

In connection with "auto-frettage," it is important to know what the elastic limit of the steel is and also the limit of proportionality. In the ordinary testing of steel the yield is often taken as the elastic limit; the yield is about 10 per cent. greater, but without an accurate extensometer on the ordinary testing machine it is difficult to ascertain the limit of proportionality and the elastic limit. Both can be readily obtained by means of the Dalby instrument, which gives an easily measured magnified photographic record.

In the descriptive matter the author evidently considers the French 75 mm. field gun and carriage, 1897 model, and the French 155 mm. heavy field gun and split trail carriage, model 1918, very good examples for instructional purposes, and has given a minute description of the first-named, including a good description and illustration of both recoil systems. In these carriages the recuperator is of the floating piston type with compressed nitrogen instead of air to give the run-out force. It is stated that the general features of the United States 155 mm. gun and carriage, 1920 model, are based on the French model.

The complex theory of rifling could have been dealt with to a greater extent than has been done in either this or previous textbooks. So far as the reviewer knows, no one has tackled this intricate problem since Sir George Greenhill published his investigations many years ago; but the modern streamline form of projectile approximates closely to Greenhill's assumption of a hollow ellipsoid. As a matter of fact, Greenhill had the intention of again giving attention to this subject when his death unfortunately took place in February, 1927.

The new method is introduced for the calculation of trajectories based on the French investigations during the war—by Garnier, Haag and Marcus. It is essentially a short arc method and a summation is necessary of the respective components to give the final result. The space allowed naturally only admits of the absolute fringe of the subject of exterior ballistics being touched, and the student will have to refer to a special textbook if he wishes to delve deeper into the subject. The amount of information required in the range tables, which at one time were a simple tabulation of ranges and elevations, now comprises a small book in itself, embodying particulars of changes for temperature and height of target, besides corrections for wind and alterations for weight of projectile and change in velocity. All these poinss are touched on in the book and afford most interesting reading for the student.

The book ends with a few lines regarding "Big Bertha," with which the Germans shelled Paris from a range of some 72 miles.

Suspension Bridges: Their Design, Construction, and Erection. By D. B. Steinman, Ph.D., M. Am. Soc. C.E. Second edition. London: Chapman and Hall, Ltd. 1929. Price 25s.

Since many books on bridges consist largely of descriptive matter and data relating to considerable numbers of individual structures, it is to be noted that, as indicated by the words "A practical treatise on . . ." which precede the title proper, this work is strictly confined to its purpose as expressed in the sub-title. Accordingly, while the designs and the erecting of some individual bridges are fully described and discussed, usefully exemplifying the author's presentment of the subject, references to other works are confined to such as illustrate specific points, while the broader subject of the conditions under which suspension bridges may provide the most economical and satisfactory solutions of bridging problems is not considered, except in a brief elementary explanation of the reasons for "the superior economy of the suspention type for long-span bridges." The book, therefore, begins at the point at which it has been decided that a suspension bridge shall be built. Further, although the design and building of the piers of suspension bridge towers may, in a given case, present problems which would not arise had a bridge of some other type been adopted, the author, regarding this matter as pertaining to bridge building in general rather than as proper to his subject, is content to put it aside, thus:—"The pier does not involve any special features differentiating it from ordinary bridge piers." Lastly, in this connection, the author's treatment of anchorages is not, in proportion to the number and importance of the problems and the variety of conditions, quite so thorough as is his treatment of the spans; this being probably due to his realisation of the fact that, in anchorages, structural necessities are usually more important than economy of design or in the use of materials; so that this part of the subject is most usefully studied by means of actual examples.

There is some further concentration of the author's very well-directed effort to produce a complete exposition in 291 pages, in that, although the work of other engineers is duly recognised in a number of important cases, the book more especially presents the work, in recent years, of the author and his partner Mr. H. D. Robinson. The applications of the studies of stresses, types, and stiffening trusses, and the use that can be made of the design computations and the information respecting methods of erection are, therefore, precisely such as have been made by the author himself in the design and erection of very important bridges.

In the general revision for the present edition, attention has been given to formulæ for temperature stresses, to the proportioning of cable bands, and other matters of detail, while four new appendices have been furnished, comprising a discussion of the deflection theory; a chronological table of suspension bridges; a description of the Florianopolis Bridge, as an example of the latest developments in the design and construction of eye-bar suspension bridges; and a description of the Ohio River Bridge at Portsmouth, a modern wire cable bridge of ordinary length. Though included in the author's list of portions of the text that have been re-written or revised, the passage relating to multiple-span suspension bridges consists of only fifteen lines, citing the cases of Lambeth Bridge and the former Seventh-street Bridge at Pittsburgh, and condemning the type as inefficient.

The author specially directs attention to Appendix D, on the Deflection Theory, which presents the "more exact" method of computing stresses in suspension bridges, originated by J. Melan and published in 1888 and, in amplified form, in the 1925 edition of his book "Theorie der eisernen Bogenbrücken und der Hängebrücken."

The chronological table begins with the river Tees Bridge, a chain bridge of 70ft. span, erected in 1741, which had a life of sixty-one years. Forty-four years later a chain bridge of 98ft. span was erected at Weilburg, Germany. Including these two, twenty-seven of the first thirty-one suspension bridges were of the chain type, and five of these—three of them British—are yet standing: at Berwick, the Tweed Bridge, 449ft. span, 1819; a footbridge at Nuremberg, Germany, 1824; the Tain-Tournon Bridge, France, spanning the Rhone, 280ft., 1824; Menai Bridge, 580ft., 1826; Conway Bridge, 327ft., 1826.

The first cable bridge in the table is that at Schuylkill Falls, Philadelphia, 408ft. span, 1816, which had, however, a life of only one year. A chain suspension bridge erected at the same place in 1909, 153ft. span, had a life of only two years. The earliest cable bridge yet standing is that at Beaucaire, France, 1828, span 394ft.

So much of recent literature on the subject of bridge building has been devoted to forms in which reinforced concrete plays a dominant part that many bridge engineers may have failed to realise how many suspension bridges have been erected in the past seven years, that is, since the first edition of the book under review was published. The chronological table gives forty-seven which have been completed or nearly completed and two begun since 1921, eleven of the chain and the rest of the cable type. Those having spans of more than 1000ft. are at Bear Mountain, Hudson River, 1632ft., cable, 1924; at Florianopolis, Brazil, 1114ft., chain, 1926; at Philadelphia, Delaware River, 1750ft., cable, 1926; and, in 1929, all cable bridges: Mount Hope, Rhode Island, 1200ft.; Detroit Bridge, connecting Canada and the United States, 1850ft.; Mid-Hudson, 1500ft.; Hudson River, New York, 3500ft. This reference to recent activity in the building of suspension bridges is to the immediate point, in that it shows that there has been no lack of opportunity for new developments; but it is impossible to allow to pass unchallenged the statement made by Dr. Steinman in his preface to the present edition:—"During the few years since the first publication of this book, considerable progress has been recorded in the art of suspension bridge design and erection. There have been new developments in materials, forms, methods, and principles of construction." One searches in vain, however, in the book itself, for any evidence that such developments amount to very much on any of the six counts. No new principle of construction is discovered, nor any important development in design, except, perhaps, in respect of stiffening trusses, as in the case of the Florianopolis Bridge, designed by the author and his partner. As regards materials, it is recorded, page 74, that, as affecting design also, the use of heat-treated eye-bars reopened the economic competition between eye-bars and wire cables; so that whereas, in the chronological table, twenty consecutive entries of cable bridges, 1915–1922, precede that of a chain bridge completed in 1923, thereafter the list of bridges completed and those to be completed in 1929 includes eleven chain and thirty-two cable bridges. Some data as to the special steels used in the manufacture of eye-bars are given on pages 85 and 86; but nothing else that is new and important as regards materials is to be found in the book. The reader may judge for himself how far the methods adopted in the erection of the Florianopolis and Ohio River bridges, as described in Appendices B and C, involved important departures from normal earlier practice.

It may be concluded that the developments which have taken place since the first edition of the book was published in 1922, and adequately presented by the author in the new edition, give fresh interest to the work and bring it up to date, without having, as suggested by the author's sweeping statement, the effect of substantially reducing the value of the original matter. The book is well balanced and suitably illustrated, a noteworthy feature being the presentment, under the heading "Stresses," of the subject of stiffening trusses, with nine diagrams, three illustrations and a graph, followed by a study of braced chain suspension bridges. These forms are also considered under the headings "Details of Construction" and "Typical Design Computations" in combination with various forms of main chains or cables. Appendices B and C, to which reference has already been made, are very useful additions to the original work. This excellently turned out volume may be classed among the relatively few engineering books which are completely and successfully devoted to a single purpose of first importance.

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Transactions of the Institute of Marine Engineers, July, 1929. Volume XLI. London: The Institute of Marine Engineers, 85-88, The Minories, E.C. 3.

The "Gas World" Analyses of Gas Companies' Accounts, 1928. London: Ernest Benn, Ltd., Bouverie House, 154, Fleet-street, E.C. 4. Price 21s. net.

Financial and Economic Conditions in Roumania, April, 1929. By R. J. E. Humphreys. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. 6d. net.

The Structure and Working of the Australian Tariff with Particular Reference to Empire Marketing. By N. Skene Smith. London: P. S. King and Co., Ltd., 14, Great Smith-street, S.W. 1. Price 2s. 6d. net.

Public Cleansing: Collection, Treatment and Utilisation of Town Refuse. By the "Jas. Jackson" Study Circle of the Birmingham Corporation Salvage Department. London: Ernest Benn, Ltd., Bouverie House, 154, Fleet-street, E.C. 4. Price 18s. net.

An American Dynamometer Car.

WHEN the Northern Pacific Railway decided, in 1928, to improve the working of its goods traffic by introducing locomotives of exceptional size and power, it was evidently necessary to make provision for testing them very thoroughly in service, in order to determine their efficiency and economy under working conditions. For such tests the use of a dynamometer car is indispensable, but the railway company's old dynamometer car was quite unable to deal with engines of high tractive power. It was decided, therefore, to construct a new car and equip it with the most modern apparatus. This car was built at the Saint Paul works of the railway company, its design, construction and equipment being under the supervision of Mr. Zwight, chief mechanical engineer. The Baldwin Locomotive Works manufactured and supplied the dynamometer mechanism and recording apparatus.

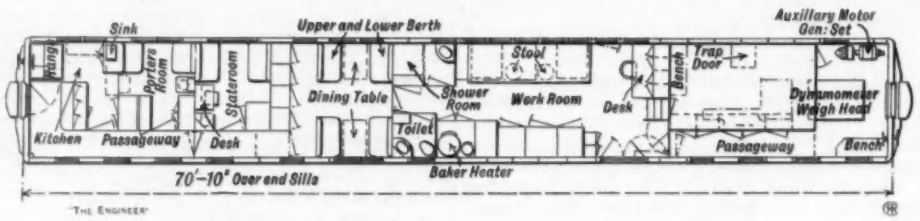


FIG. 5—PLAN SHOWING INTERIOR ARRANGEMENT OF CAR

The locomotives which are to be tested with this car, and the first of which is now in experimental service, are of the Mallet articulated type, having two eight-wheeled driving bogies, but with all four cylinders the same size—26in. by 32in.—and using high-pressure steam. The driving wheels are 5ft. 3in. in diameter. The engine has the 2–8–8–4 wheel arrangement. It weighs 350 tons, of which 275 tons are carried on the driving wheels, and it has a 200-ton tender mounted on a pair of six-wheeled bogies. The tractive effort at 70 per cent. cut-off is 139,900 lb., but with the booster or auxiliary engine geared to the trailing bogie the total tractive effort is raised to 153,300 lb. To serve locomotives of such high power the new dynamometer car has a capacity for measuring draw-bar pull up to 125 net tons and buffing shocks up to 625 tons. While dynamometer cars have been built for the Southern Pacific Railway and the Canadian Pacific Railway with capacities as high as 250 tons draw-bar pull, it will be a long while before locomotives are in service developing a tractive force higher than 125 tons.

Four views of the dynamometer car for the Northern Pacific Railway are shown on page 226. Fig. 1 is a general exterior view, with the machinery end at the left; Fig. 2 shows the chronograph or recording table with its pens; Fig. 3 is a view of the weighing head or dynamometer device mounted on the floor of the car, with motor generator set behind it; and Fig. 4 shows the work table on which the charts are studied for working up the results of tests. A folding sleeper berth is fixed over this table, and the steps lead up into the raised cupola—Fig. 1—in which the chronograph table is installed. A plan of the interior arrangement is given in Fig. 5.

In construction the car is of steel throughout. Its underframe consists of a pair of plate girder centre sills, with transverse members, and at the machinery end there is a deck plate ½in. thick extending over a length of 25ft. 6in. and the full width of the frame. This plate is riveted to the centre sills and side sills. The body framing is also of steel, with steel plating for the sides and roof, while the floor and inside lining are of tongued and grooved wood ¾in. thick. Each bogie frame is a single steel casting, mounted on six 36in. steel wheels. Clasp brakes, with shoes on each side of the wheel, are applied to all the wheels except those on the rear axle of the front bogie, the recording chart being driven from that axle by gearing.

At the front or machine end of the car is a cupola or raised portion in which the recording apparatus is placed and from which the observer has a good view of the line. Its floor is 3ft. 6in. above that of the body of the car, but at one side this floor is raised, forming an interior bench and also providing a corridor 2ft. 1in. wide and 6ft. 2in. high, thus permitting free access from end to end of the car. This arrangement is shown by the cross section in Fig. 6. The length of the cupola is 12ft. and its front end is 6ft. from the end of the car body. Sliding and stationary windows are provided, so that there is a good view for the observers, who, by means of electric push buttons, mark the chart as each station and mile post are passed. Storm hoods can be fitted to the windows for convenience in making observations in bad weather, while spot lights can be adjusted to render mile posts or other markers readily detectable at night.

At the forward end of the car and bolted rigidly to the underframe is the "weighing head," which receives and records the draw-bar pull and the buffing shocks. This device as mounted in the car is shown in Fig. 3, and the general method of its operation is illustrated by the sketch Fig. 7, while some of the details of its construction are given in Fig. 8.

In a massive casting having a flat base 4ft. long and 2ft. wide are formed two horizontal cylinders, about 22in. apart, the one for draw-bar pull being at the rear and the one for buffing shocks at the forward end of the casting. They are 11¼in. and 16in. in diameter respectively, and in each is a piston 4in. long with a short piston-rod at the inner side. An interesting feature introduced to minimise the friction is that each piston rides on six horizontal ball bearings parallel with the axis of the cylinder. Horizontal semi-circular grooves or races are formed in the bearing surfaces of the piston and the cylinder wall. These races are 3in. long and in each race are seven balls of hard steel ¾in. in diameter. The effective area of the pistons is 100 square inches for draw-bar pull and 200 square inches for buffing.

Dished cylinder heads are bolted to the outer ends of the cylinders, the concave space in the head being closed by a diaphragm consisting of a flat disc of leather $\frac{1}{16}$in. thick bolted between the flanges of the head and the cylinder casting. The diameter of the diaphragm is 18¾in. for the pulling and 22in. for the buffing cylinder. The concave space in the cylinder head, closed by the diaphragm, is filled with a mixture of glycerine and alcohol. The head on the pulling cylinder is 20¼in. diameter, with the concave or dished portion 11¾in. in diameter and 1¼in. deep. On the buffing cylinder the head is 23¼in. in diameter, with its dished portion 16¼in. in diameter and 2⅜in. deep.

Between the back heads of the cylinders is the upper end of a heavy vertical lever, fulcrumed on a pin in the centre sill and attached to the draw-bar by a smaller pin. Both pins have roller bearings in order to reduce the friction, while the piston-rods have knife-edge bearings on the edges of the lever. The

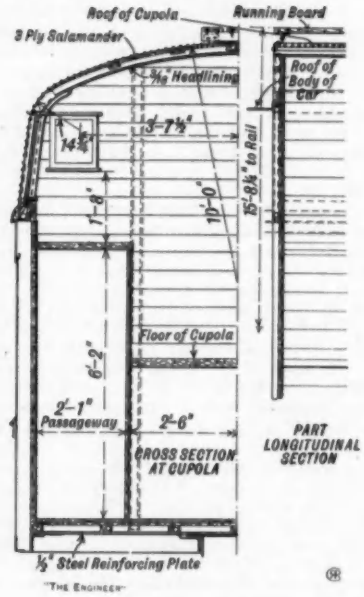


FIG. 6—SECTIONS OF CAR

lever gives a ratio of 2½ to 1 between the centre line of the draw-bar and the knife-edge contacts.

Each piston has a maximum travel of ¾in. in either direction from the centre. When the apparatus is not in use the yoke lever is held by jack screws. When tests are being made these screws are backed off about ¼in. to permit free movement of the lever and pistons. If there should be an insufficient amount of liquid in the cylinder head the lever would travel far enough in to come in contact with the jack screw. In such case the contact closes an electric circuit which rings a bell in the cupola, notifying the observer that liquid must be added to restore the apparatus to proper condition for testing.

A worm gear on the rear axle of the front bogie drives a shaft from which a train of bevel gears transmits the motion to a vertical shaft which extends up to the speed-changing box on the floor of the cupola. From this box the roll of the travelling chart is driven. A square-jaw clutch in the axle gear case which is controlled from the cupola, serves to engage or disengage this paper-driving mechanism. Three speeds of the chart are given by the speed-change box: 3·30in., 13·20in., and 52·80in. per mile of travel by the car. The 13·20in. speed is the most satisfactory for ordinary work. If the chart is to be driven when the car is not in motion, or if it is desired to drive it at a certain travel per minute of time instead of per mile of distance, the roll mechanism can be operated from the constant-speed motor used in connection with the speedometer. This permits three rates of travel: 3¾in., 15in., and 60in. per minute.

This paper chart which travels over the chronograph or recording table—Fig. 2—is 24in. wide. Above it is a bridge or bar carrying twenty-two pens, which record the following events consecutively from left to right of the paper:—Six-second intervals, brake cylinder pressure, right-hand water meter, left-hand water meter, train pipe brake pressure, front air brake pump, rear air brake pump, steam pressure, coal or oil fuel consumption, feed water pump, back

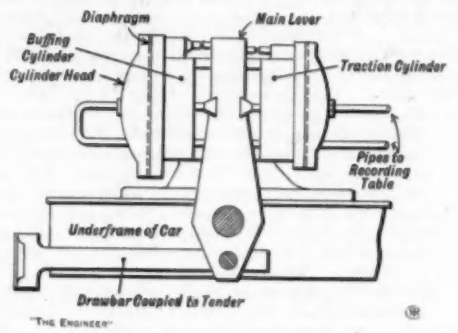


FIG. 7—WEIGHING HEAD

pressure, locomotive indicator, integrator, draw-bar pull, buffing shock, reversing lever position, regulator, speed, distance marks, mile posts and stations, one-minute intervals, six-second intervals. Datum reference lines are needed for brake cylinder pressure, train line pressure, back pressure, steam pressure, draw-bar pull, buffing shock and speed. Instead of pens, however, these lines are marked on the paper by aluminium rollers on a shaft extending across the table. Each roller has a sharp flange which marks the line and a tread on which is a stamp to designate what the line represents. This stamp comes into contact with an inking pad at each revolution. With this arrangement, which is quite new for dynamometer records, the datum line is very fine and there are seven less pens to watch than if the datum lines were marked by pens in the usual way. The six-second interval marks along each border enable the observer to draw lines squarely across the chart.

Steam or engine indicators mounted beside the recording table are adapted for making the records of brake cylinder pressure, brake train pipe pressure, steam pressure, back pressure and buffing shock. For each indicator the pencil motion is extended through levers to the proper position on the chart. For the draw-bar pull record a cylinder is mounted

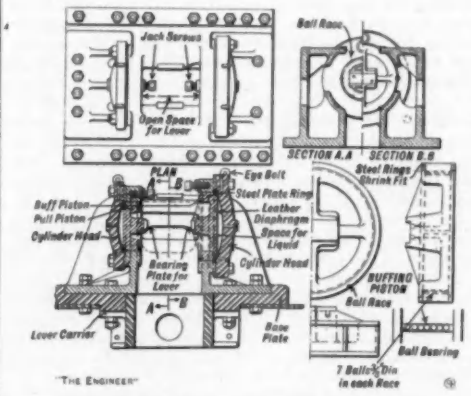


FIG. 8—DETAILS OF WEIGHING HEAD

rigidly on the table and pressure from the rear cylinder of the weighing head is transferred to the table cylinder by a pipe. This pressure is exerted against a piston, the movement of which is resisted by a calibrated spring having one end fastened to the piston-rod. This rod, in turn, actuates a lever which gives motion to the pen arm, having a full travel of 3in. With different springs this pen travel is obtained with seven rates of draw-bar pull, ranging from 25,000 lb. to 250,000 lb. On the table is also mounted the integrator, which makes one revolution for each 3 square inches of area between the draw-bar pull line and its datum line. A commutator on the integrator shaft records each revolution of the integrator by a mark on the chart, and a counter automatically indicates the number of revolutions and 3in. areas.

Eight electrically-operated counters record the numbers of integrator revolutions, 100ft. distance marks, right and left-hand water meter revolutions,

coal or oil meter revolutions, strokes of front and back air pumps and strokes of feed water pumps. An electric 30-volt constant-speed motor of ¾ horse-power, running at 1725 revolutions, operates the speed recorder and speed indicator, and also operates the drive for the travelling chart when it is desired to use this while the car is at rest. A governor on the motor shaft regulates its speed very closely, while the final adjustment of speed is effected by a face-plate rheostat connected in series with the motor field. This motor is on the floor of the cupola, and above it are a voltmeter and a speedometer which indicates the speed of the motor.

This motor transmits constant speed to a horizontal disc, upon which rests a vertical disc driven from one of the car axles. With the car at rest the vertical disc is stationary and stands at the centre of the revolving horizontal disc. When the car is in motion the vertical disc is also revolving and occupies that position on the horizontal disc where the speeds of both discs are the same, its distance from the centre of the horizontal disc indicating the speed of the train. The shaft of the vertical disc is mounted in a carriage which has a lateral travel on rollers, its movements actuating the speed indicator gauge and also producing a graphical record of the speed on the travelling chart. Normally the recorder and indicator give the true speed, but by means of a shift lever these instruments may show double the true speed. This arrangement is convenient for close readings of slow speeds. It is important also in figuring the indicator cards, as the speed should be known as nearly exactly as possible.

A clock mounted on the gauge board makes an electrical contact every minute and thus marks the minute intervals on the chart. The six-second intervals are marked along both sides of the chart by means of the constant-speed motor already noted. On this gauge board are also a duplex air gauge, steam pressure gauge, draw-bar pull gauge, clock relay, integrator relay and the alarm bell to indicate lack of sufficient liquid in the weighing head. Push-button switches at the cupola windows and on the chronograph table provide for indicating on the chart the locations of stations and mile posts as the car passes them. Telephone communication is provided between the operator or observer in the cupola and an assistant in the cab of the locomotive.

Adjacent to the machine room or cupola is the office or working room, where the record charts can be studied, data worked up and reports prepared. This room, 17ft. 6in. long, is shown on the plan, Fig. 2, and by the interior view, Fig. 4. On one side is an oak table 3ft. wide and 10ft. long, having winding rolls at the ends for convenience in handling the long rolls of record charts. Above the table is a folding sleeping berth and a cupboard for filing plans. A roll-top desk is placed against the partition between the working room and the cupola, and above it is a bookcase and locker. Five windows give good light at the table, while electric lights having reflectors are also provided. For ventilation a 12in. electric fan is mounted at each end of the room.

In view of the long trips to be made and the amount of work to be done in this car, special attention has been given to the living quarters, which occupy about half the length of the car, as shown by Fig. 5. The operator or official in charge of the work has a private cabin or stateroom, with desk, washstand, clothes locker and double seats convertible into an upper and lower sleeping berth. Between this room and the work room are two sleeping sections with upper and lower berths, providing for four assistants, each having also a private locker against the rear partition. Portable tables can be placed between the seats for serving meals. Beyond the stateroom is a room for the porter or attendant, with narrow seats forming upper and lower sleeping berths. Other accommodations include a toilet room and a shower-bath room. At the rear end of the car is a kitchen, 7ft. 3in. square, with cooking range, metal-lined work table and sink, refrigerator and cupboards. Two copper water tanks of 126 gallons capacity are connected to a heating coil in the range.

For heating and lighting throughout the car there is ample equipment. In addition to a hot water heater serving the pipes and radiators in the several rooms, there is a smaller laundry type heater, both of these using coal fuel. Besides the tanks in the kitchen there are hot and cold water gravity tanks for the shower bath and toilet, and a 135-gallon cold water tank with air pressure is hung under the car. Thus there is capacity for 126 gallons of hot water and 126 gallons of cold water by gravity and 135 gallons of cold water under pressure, or a total of 387 gallons. When the car is not coupled in a train the air pressure for the tank is furnished from a motor-driven compressor operating at 500 revolutions. An automatic switch starts the motor when the receiver pressure falls to 10 lb. and stops it when the pressure reaches 25 lb.

For lighting, a 4-kW 32-volt generator is driven by a belt from one of the axles of the rear bogie, and there is a 600 ampère-hour 32-volt storage battery. As this car is operated mainly in goods traffic and at relatively low speeds the axle generator unit is arranged to cut in when a speed of 7½ miles an hour is attained. In its service the car is likely to be held for several days at termini or outlying points where no facilities are available for charging the storage batteries. To meet this condition a motor generator is provided. It consists of a single-phase, 110-volt, 60-cycle motor running at 1750 revolutions and directly connected to a 3-kW, 40-volt, direct-current generator. This unit operates on either 110-volt or 220-volt alternating current and is provided with a starting compensator and charging panel.

In the sample of a record chart shown by Fig. 9 the seven straight lines marked by heavy bent arrows are the datum lines already mentioned. Beginning at the top, there is first the line marked with six-second intervals. Then come the brake cylinder pressure line and its datum line, with the revolutions of the mechanical stoker marked on the next line. Next comes the train pipe brake pressure line, with its datum line below. Two lines then record the strokes of the two air pumps for the brakes. Below these is the record of steam boiler pressure on the engine, with its datum line below. These are followed by the record and datum lines of back pressure, and then the record line of the integrator.

Then comes the draw-bar pull datum line, with the recorded line below it. Next is the datum line for buffing shock, but no record line for buffing is shown on this chart. Below is the datum line for speed, followed by the line of recorded speed. Finally there are four recorded lines for 100ft. distance marks, station and mile post positions, one-minute intervals and six-second intervals. These make twenty-one lines traced on the chart, the only event not recorded in this case being the buffing shocks.

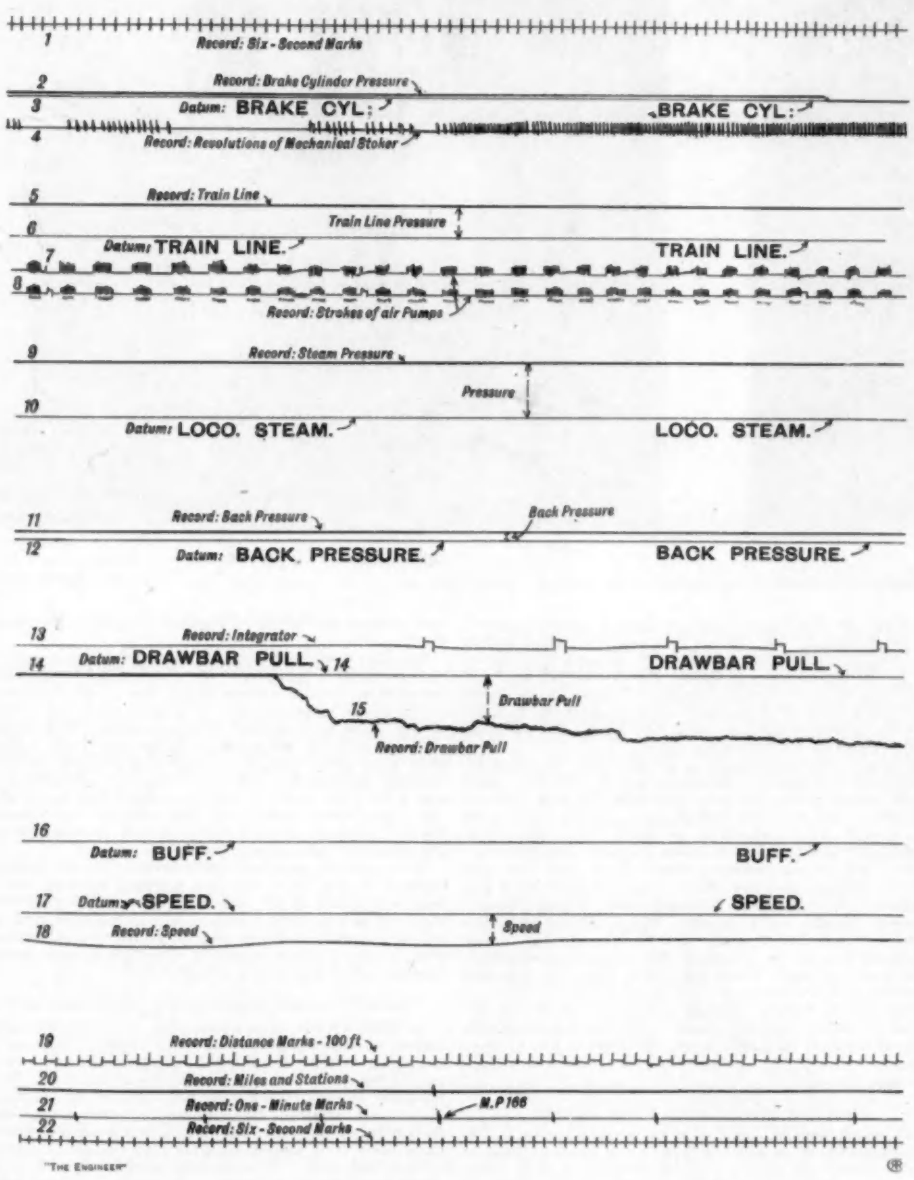


FIG. 9—REPRODUCTION OF A PORTION OF A RECORD CHART

Recent Developments in Air Transport in the United States.*

By P. G. JOHNSON,† Seattle, Wash.

TEN years ago a daily round-trip flight of Government-owned and operated mail planes, between Washington, D.C., and New York, represented commercial air transport in the United States. To-day commercial aviation, statistically expressed, is as follows :—

There are approximately 21,000 miles of established airways over which mail express and passenger planes, operating on regular schedules, will fly in excess of twenty million miles this year. Mail planes, now serving 108 cities in thirty-seven states, will transport more than 3000 tons of letters exclusive of express and passengers, and an estimated load of 300,000 lb. of express. The total mileage of civil flying was 40,000,000 miles in 1928, and that figure will be substantially exceeded this year. There are 12,000 miles of lighted airways, and one American company, the Boeing System, which flies 46 per cent. of its total mileage at night, does more night flying than all the European companies combined.

There are 1600 improved, or semi-improved, air ports, the majority muncipally owned. The value of existing air terminals is 100,000,000 dollars, and this year approximately 200,000,000 dollars will be spent by 1100 air ports for land, improvements, equipment, and supplies. These figures are important, because they express facts showing that commercial aviation has passed into the era of extensive operations, and that transportation of mail, express, and passengers by air already forms an important link in our national chain of communication and transportation. Even more significant is the fact that practically all the development cited above has come about in two years. Commercial aviation progressed more rapidly in 1927 and 1928 than it did between 1903, when the Wright Brothers made the first successful flight with the powered airplane, and 1927. For a decade after the first successful flight aviation was in the doldrums. It took a world war to hasten the development of the airplane and prove its possibilities, and also to recruit the *personnel* for peace-time use of the plane. But after the Armistice the aircraft industry paid the penalty exacted by reason of the sudden cessation of buying orders on military account, and until 1923 the industry was at low ebb.

Then the Government stepped in to play a constructive part. The Department of Commerce assumed the sponsoring and regulation of air traffic and the Army and Navy embarked on a building programme calling for 3200 planes over a five-year period. The Post Office Department, which had done a splendid job pioneering with the air mail, expanded its activities, and around the air mail network this nation began to build its commercial air transport system. In 1927 the Post Office Department discontinued its operation of the mail routes and private contractors took over the work and put into it the organisation ability, initiative, and enthusiasm so characteristic of private enterprise.

Then came that which fanned the growing flame of

* Contributed by the Aeronautic Division for presentation at the Semi-Annual Meeting, Salt Lake City, Utah, July 1st to 4th, 1929, of the American Society of Mechanical Engineers.

† President, Boeing Airplane Company, Boeing Air Transport Inc., and Pacific Air Transport.

TWO LARGE DRAWING PRESSES

(For description see opposite page.)

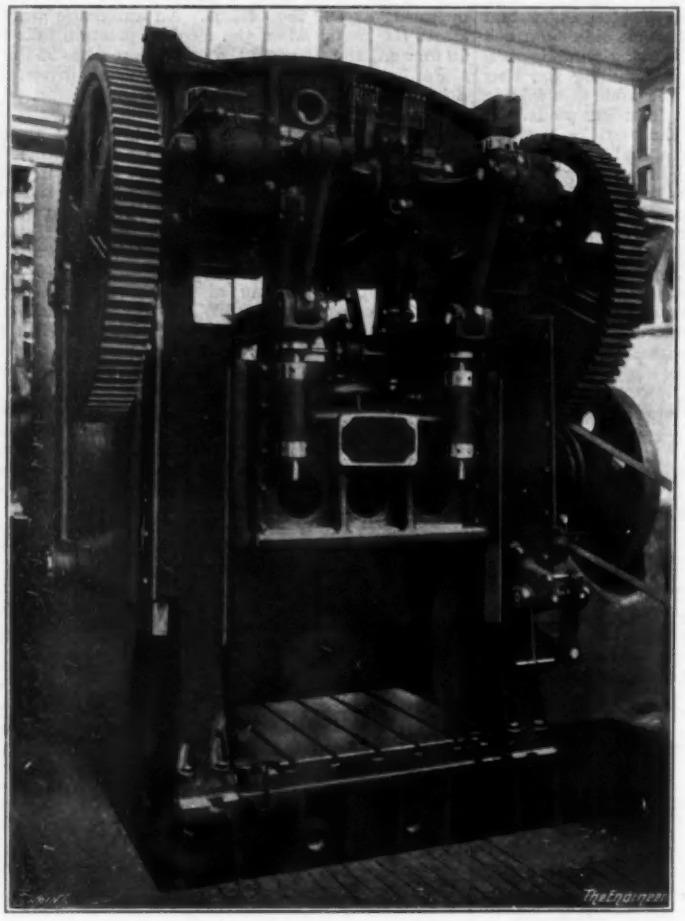


FIG. 1—160 TON PRESS

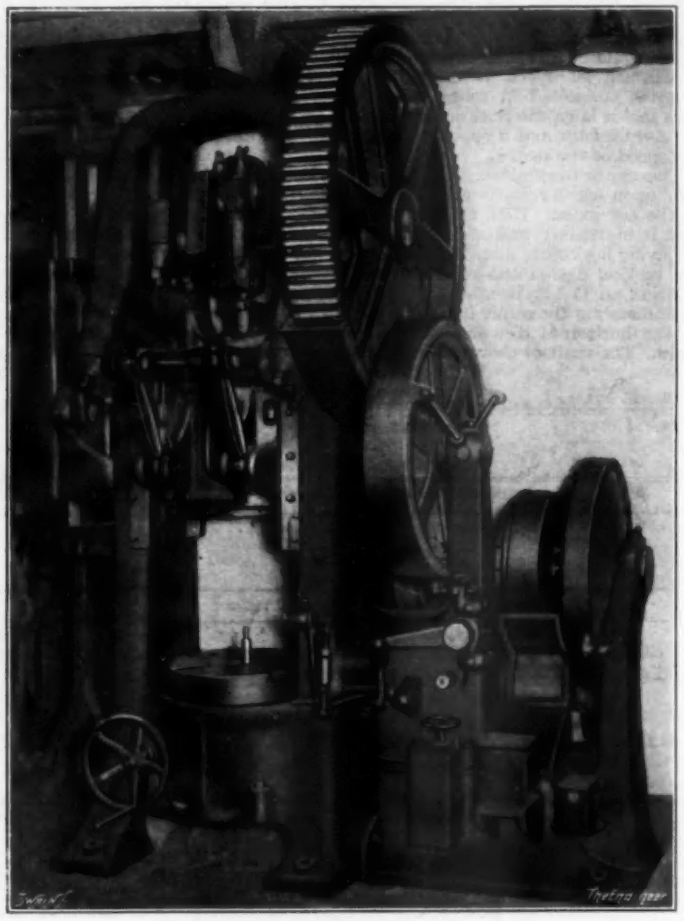


FIG. 2—100 TON PRESS

aviation interest—the Lindbergh flight, followed by other transoceanic and transcontinental trips.

RECENT GROWTH OF AIR-MINDEDNESS.

The public began to become air-minded and suddenly realised that the airplane was the latest and most effective transportation vehicle available in the ceaseless fight against time and space. People wanted to ride in airplanes and they began to send mail and express matter in an increasing volume. Airplane manufacturers and operators capitalised on this interest. Powerful banking groups looked into the future and made funds available for all legitimate expansions.

An index of how suddenly this air-mindedness has come about is seen in the following figures on production of planes in the United States:—1919, 622 planes; 1921, 302 planes; 1923, 587 planes; 1925, 789 planes; 1926, 1186 planes; 1927, 1962 planes; 1928, 4000 planes; and for 1929 an estimated production of 12,000 planes. The production in the early years cited was largely military, and in 1921 practically every plane sold was for army or navy use.

Other figures show the recent trends in commercial aviation and point to the future. The air mail carried in 1928 was 2·37 times that transported in 1927, and more striking still was the transportation of practically twice as much mail in the last five months of 1928 as during the first seven months of the year. Planes in commercial use over scheduled routes numbered 128 in 1927 and 227 in 1928, while the total of civil planes increased from 3731 in 1927 to 7800 in 1928.

Thus we see the aircraft industry was lifted from the doldrums by the war and dropped back into lean years after the Armistice, with a revival in 1927, followed by the present rapid expansion. We are now in an era of keen competition featured by mergers and consolidations. Efficiency will count much more than it did in the experimental and colourful days of the past. The dominant survivors will be factories and operating companies which are well managed and financed, and fortified with designing and manufacturing staffs capable of keeping pace with the changes which we recognise will come in both the building and operating sides of this industry.

SOME OF THE DEFINITE TRENDS OF THE FUTURE.

The experience of the past indicates some of the definite trends of the future. To date, the largest expansion has been in the carrying of mail and passengers, and the majority of lines have carried both on the same planes. However, air mail loads have so increased and schedules of departures and arrivals are at such inconvenient hours in many cases that there is a growing tendency to separate mail and passengers. Different kinds of operations call for different types of planes. The air traveller pays more for transportation than the rail traveller, and he expects schedules and comforts which often cannot be given him when transportation of mail is the prime consideration.

Assistant Postmaster-General Glover recently predicted that all first-class mail between certain communities will be carried by air. The Post Office Department averages daily 476 tons of first-class mail which must be given transit handling. So the future of the airplane as a mail transport can be visioned. Mr. Glover also predicted that within two years practically all cities of 50,000 or more inhabitants will be located on air mail lanes. He pointed out that the busy man has always been impatient regarding the speed with which his mail is handled, and will naturally demand that all first-class mail be given the speed that air mail now receives in the fast-flying planes.

It is not idle speculation to predict that the airplane companies will build mail planes which will have mail clerks aboard just as railway mail cars do, and that the mail planes will haul the bulk of their cargo between dusk and dawn. The airplane is so speedy that already it eliminates the loss of any business hours in transportation of mail and express between many cities. For instance, between Chicago and New York; between New York and Atlanta, Ga.; between Chicago and Dallas, Texas; between Chicago and Cheyenne, Wyo.; and between San Francisco and Los Angeles and Cheyenne, Wyo. The schedules can so be arranged that major cities within 1200 miles of each other can have their mail moved between dusk and dawn.

The Boeing System recently completed flying its two millionth mile of night flying and on May 1st, when a double transcontinental schedule went into effect, planes were flying every hour of the night with mail between New York and San Francisco.

AIRPLANE TRANSPORTATION OF EXPRESS.

Air transportation must also be reckoned with in the transportation of express. Robert E. M. Cowie, President of the American Railway Express, in a signed article recently expressed his opinion of flying express when he wrote:—

"We see the airplane as a builder of more business, basing the conviction on the history of transportation. Express companies were originally regarded as competitors of the railroad. Express tonnage is only a drop in the bucket compared to the volume and value moved in freight cars. Commercial air transport is the logical delivery system of hand-to-mouth buying, the instrument of the rapid turnover which has had so much to do with our prosperity.

"The airplane is virtually without limitations. It should open areas to settlement at present far beyond the economic reach of the motor truck and physically impossible to the railroads.

"What we need is planes in regular service with a capacity of 20,000 lb. and the ability to carry a pay load of at least 5 tons. When our air lines are equipped with such a unit, commercial aviation will follow the course of every other transportation system."

In this day of small stocks, quick turnover, little profit, and a growing demand for service—which costs money—competition has become keener and business is reaching out into new and larger trade zones. Air transportation, averaging 100 miles an hour, has already begun to revamp certain long-established distribution and selling methods, just as the automobile and train left their mark on our business structure. Recently the Chamber of Commerce of a prominent city in the Middle West complained that its banks and wholesale houses were losing long-established trade because competitive cities had direct overnight air mail express service to commercial centres of the South-West.

The American Railway Express estimates that approximately 25,000,000 dollars worth of small merchandise leaves New York by express daily. New York City and its environs, said the statement, produce only one-twelfth of the small merchandise of the country. The express company fills up 500 railway express cars every night in New York alone, and in its 28,500 offices the American Railway Express handles approximately 1,000,000 packages a day, and speed is such a requisite that the coast-to-coast cars make faster time than most of the passenger trains. Airplanes of the future will have capacity for large shipments of light-weight emergency express.

But even the most optimistic commercial air transport officials do not claim that the airplane will cut into the freight revenues of the railroads. They believe, however, that the airplane, by speeding up our business structure, will so stimulate industry generally that the railroads will share in the greater prosperity which each faster form of transportation has always brought us.

CURRENT VARIED COMMERCIAL USES OF AIRPLANES.

In addition to using airplanes operated on regular routes, on scheduled services, to handle their express and to transport their employees, corporations will buy airplanes for the expedition of their own business. Executives are already flying their airplanes in the conduct of their daily affairs. Oil companies, newspapers, manufacturing plants, wholesale houses, and other corporations have their own planes, ranging from single-motored to tri-motored craft. The airplane is used in such a wide variety of pursuits as aerial photography, airplane dusting of crops, forest patrol work, scientific studies, aerial advertising, spotting schools of fish, map making, geographical study, engineering surveys, carrying supplies to inaccessible regions, transporting emergency shipments of factory parts, and in many other ways. These instances indicate the expanding market for airplanes. Each day the air transport companies hear of specific cases where the airplane has opened up new markets and speeded up business generally, which explains why it is being utilised by business in ever-increasing measure.

The experience of the past two years shows that the passenger side of air transportation can be expanded substantially and quickly. The public is ready to fly. The air transport companies are prepared to supplement the present services so that, in a few years, major cities in the United States will be connected by air transport services, and many of them will operate multi-motored planes with a cruising speed of 115 to 135 miles an hour. The public is willing to pay the higher rate charged for air transport.

INCREASED PASSENGER TRAVEL BY AIRPLANE.

The average charge, over the United States, for air travel is 11 cents a mile according to a compilation made by the traffic department of the Boeing System. If a traveller purchased a ticket for a one-way trip over every line in the United States offering passenger service and operating on a regular schedule, he could travel 12,914 miles. For this air travel he would pay 1427 dollars, or 11 cents a mile. The extra-per-mile charge for airplane travel over rail

travel is more mathematical than real, however. The air mileage between cities is generally considerably less than the rail mileage charged for. There is no Pullman or chair car charge on airplanes or taxi fares to and from terminals, as these are included in the airplane ticket. Also, the airplane is three and sometimes four times as fast as train transportation; and if time is money, it is more expensive to travel by train than by plane.

Railroad executives with vision do not regard the airplane as an intruder, and many of the lines sell combination rail-plane tickets. Among these companies are the New York Central, Pennsylvania, Santa Fé, Illinois Central, Chicago and North-Western, the Milwaukee System, Great Northern, Northern Pacific, Missouri Pacific, and others.

At what mileage air transport companies can compete for traffic with railroads is a debatable question. European authorities, a year ago, thought 300 miles was the minimum, but Germany is proving that this figure is too high. There, with the aid of a federal subsidy which enables them to quote mileage rates quite comparable to rail tariffs, one German company has hauled 56,000 passengers in one year, or one-tenth of the first-class rail passengers of the German lines, and their average air haul was only 93 miles.

At the present time transport companies in this country find it difficult to secure sufficient passenger lists on routes less than 300 miles long. But the American's inborn desire for speed will probably assert itself when commercial aviation is a little older, when the companies have brought their passenger service to high efficiency, when air ports are closer in, and when the public becomes a little more air-minded. In the future air transport companies will not limit their operations to arbitrary distances, but will adjust the service to meet the demand, irrespective of the length of haul.

Passenger travel by airplane is certain to increase because the public embraces each form of faster transportation. Airplane travel is speedy, comfortable, and interesting, and the operators are bending every energy to make it as safe as any form of mechanical transportation.

The public pays an extra fare on faster trains like the Twentieth Century and the Broadway Limited. Speed is expensive, but the travellers are willing to foot the bill, especially when the airplane is three times as fast as rail transport. A plane with a cruising speed of 90 miles an hour is already becoming slow to some confirmed air travellers, and the airplanes of the future will undoubtedly be more speedy than any of those now flown on commercial routes. Airplane engineers are planning larger, faster, and more comfortable transports. The safety factor is increasing each year through improved equipment, more and better air ports, more experienced pilots, better weather reporting, lighting and marking of airways, the directive radio, the radiophone, and other aids.

The manufacture and operation of airplanes is not merely a matter of mechanics, but of "humanics." To give the airplane its rightful place in our national system of communication, transportation, and distribution calls for vision and initiative, but the recent developments in air transport indicate clearly that we are making rapid progress toward our goal.

Large German Drawing Presses.

IN our description of the machinery at the last Leipzig Fair we referred to some very large drawing presses exhibited by Messrs. Götz Brothers, of Lauter, Saxony. We are now able to illustrate two of these machines and furnish a more adequate description of them. The press, of which an engraving and drawings are given in Figs. 1 and 3 respectively, is the largest but one of a series of five of the type designed for all kinds of drawing, deep stamping and forming operations as required in the manufacture of motor car body work, fenders, oil pans, radiator casings, metal furniture, &c. The machine in question was employed at the Leipzig Fair in making mudguards for motor cars. The whole of the framing is made of steel castings, four large steel tie bolts taking the stress when the machine is working. The blank holder is also of cast steel and is operated by a system of toggles. The shafts carrying the toggle levers run along the front and back of the head of the machine, and are worked from slides in the side frames, the slides being actuated by connecting-rods from the large gear wheels. The drawing head slides in the blank holder and can be raised or lowered by a separate electric motor. It is provided with T slots to which can be bolted the dies. Both the drawing head and the blank holder are largely counterbalanced by the crosshead slides and the balance weights in the large gear wheels. The crank shaft is of hammer-forged steel and is driven from both ends by the gearing. The latter is of the double-reduction type. The press is provided with an adjustable friction clutch with unusually large friction surface and no springs. The engagement of the clutch and the simultaneous operation of the differential band brake are both effected by a hand lever, and the press can be stopped in any position. Since these large presses are usually attended to by workmen on each side, a safety lever is provided on the back, which has to be released before the press can be started from the other side. The entire clutch runs on ball bearings and double-thrust bearings of the same kind take the end thrust. Pneumatic die bolsters are provided for very deep drawing, enabling work to be done in one operation which would otherwise take two or three. The pneumatic bolsters further provide an even pressure on all parts of the blank, produce better stampings, and allow the pressure to be regulated as desired.

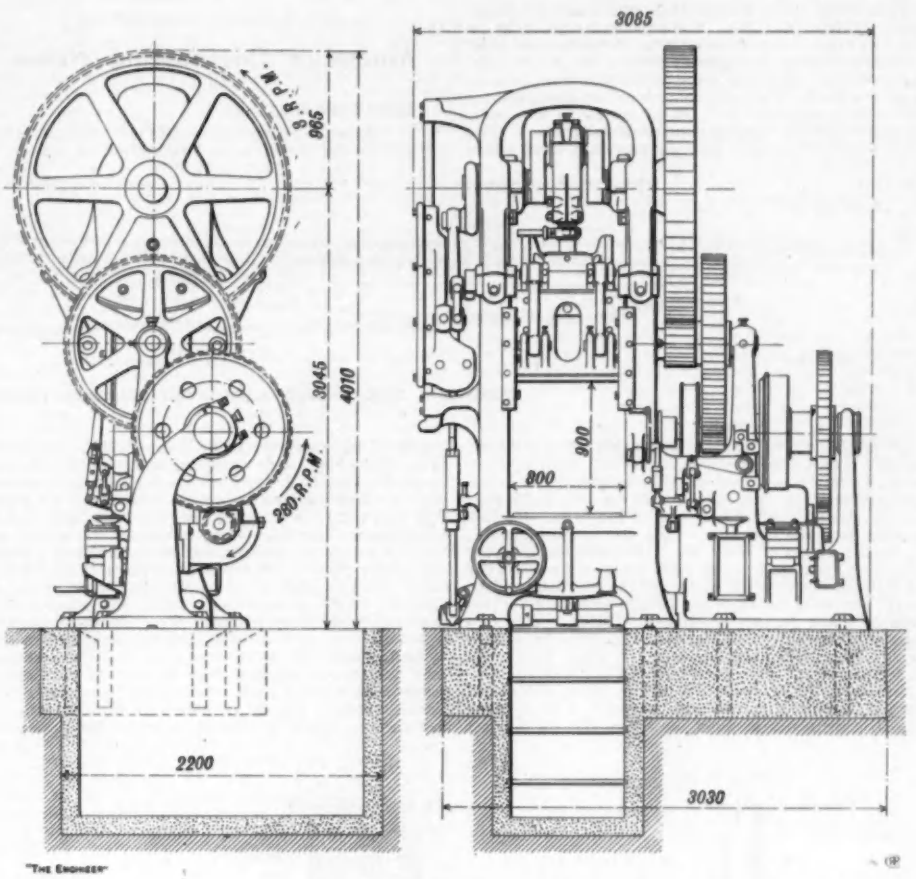


FIG. 4—ARRANGEMENT OF 100 TON PRESS

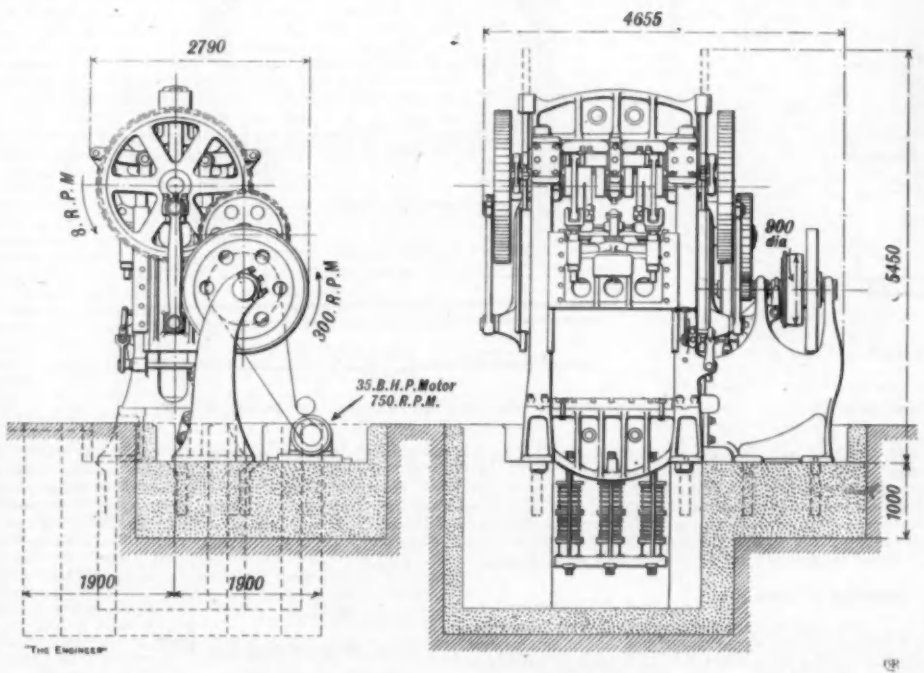


FIG. 3—ARRANGEMENT OF 160 TON PRESS

The following are the principal particulars of the machine illustrated in Figs. 1 and 3 :—

Width between frames	63in.
Maximum depth of draw	11·8in.
Area of table	63in. × 47·2in.
Area of slide	43·3in. × 28·5in.
Stroke of blank holder	15·7in.
Stroke of slide	25·6in.
Adjustment of blank holder	5·6in.
Adjustment of slide	5·6in.
Daylight to blank holder	47·2in.
Daylight to slide	59in.
Drawing pressure, approx.	125 tons
Finishing pressure, approx.	160 tons
Strokes per minute	Eight
Thickness of bolster plate	5·2in.
Weight of machine	43 tons

The press is driven by a 35 B.H.P. motor belted on to a 36in. pulley running at 300 revolutions per minute. The auxiliary motor for raising the slide is of 4 B.H.P.

The smaller machine, illustrated in Figs. 2 and 4, is more especially suited for work which needs a heavy final pressure, such as dishes, plates, pot lids, &c. The body is made in a single casting. The mechanism is driven by a motor through triple-reduction machine-cut gearing. The crank shaft operates the drawing slide directly by a connecting-rod, and the blank holder slide by a toggle gear driven from an overhung crank pin at the end. The table can be easily adjusted to height by a hand wheel and worm gear. A friction clutch on the second-motion shaft permits the press to be started and stopped in any position, though it stops automatically after every stroke with the blank holder, and the drawing slide both at their highest points. Ball bearings are provided both for the second-motion shaft and for the clutch gear.

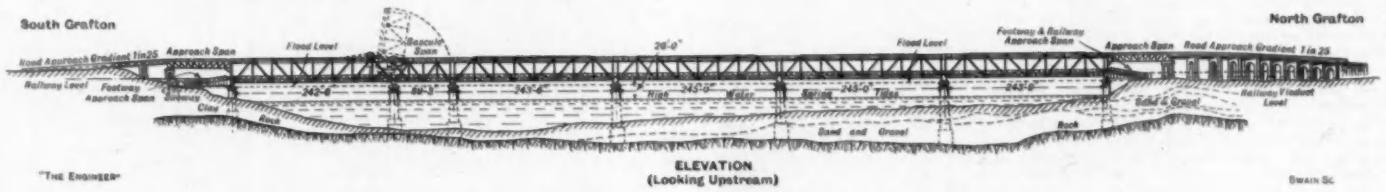
The machine, which is the largest of a range of five sizes, has the following dimensions :—

Width between frames	31·5in.
Maximum diameter of blank accommodated	27·5in.
Maximum diameter of drawing punch accommodated	19·6in.
Maximum depth of draw	9·8in.
Stroke of blank holder	13·0in.
Stroke of drawing slide	21·6in.
Adjustment of slide	4·7in.
Adjustment of table	7·0in.
Daylight to blank holder	35·4in.
Daylight to slide	53·9in.
Drawing pressure, approx.	75 tons
Final pressure, approx.	100 tons
Strokes per minute	Eight
Weight of machine	15·3 tons
Power required, approx.	8 B.H.P.

ONE of the works proposed to be carried out under the East Africa Guaranteed Loan Act of 1926 was the extension of the Tanga–Moshi Railway in Tanganyika Territory, from Moshi to Arusha, a distance of about 50 miles. The announcement has now been made by the Secretary of State for the Colonies that the new line reached Arusha on August 14th.

New Road and Rail Bridge in New South Wales.

The accompanying engravings represent a new road and rail bridge which is at present under construction in New South Wales. It is to carry a portion of the highway and railway between North and South Grafton across the Clarence River near Wilson Hill and close to South Grafton Railway Station. The superstructure is to be carried on seven concrete piers taken down to solid rock which lies at depths varying from 30ft. to 76ft. below high-water level, the tallest pier being about 98ft. from foundation to top level. They are being built on steel caissons sunk under compressed air. There are to be five main fixed spans and one opening span, with an approach span at either end. Curiously enough, the main fixed spans



ROAD AND RAIL BRIDGE ACROSS THE CLARENCE RIVER, N.S.W.

are not all of the same length, though there does not seem to be any reason why they should not be. Starting from the South Grafton end, that is, at the left-hand side in the elevational drawing, there is, first of all, a span of 242ft. 6in., then the opening span, then a span of 243ft. 6in.—or just 1ft. more than the first span—then two spans of 245ft., and, finally, a span of 243ft. 9in. The two piers carrying the opening span are to be at 89ft. 3in. apart, so that the total distance between the centres of the end piers will be 1309ft. The total length of the bridge, including the two approach spans is, approximately, 1510ft. The two trusses of the spans are to be arranged at 28ft. 6in. centres apart. The opening span provides a clear fairway of 76ft. 9in. between piers. The underside of the bridge is to be 26ft. above high water of ordinary spring tides, and there will then be a depth of 44ft. of water at the opening span. During times of flood, however, the water level rises very considerably, the highest known flood level being only 4ft. below the underside of the structure.

The moving span is of the single hinged leaf bascule type. It will be hinged on a pair of rollers, which will move away from the opening simultaneously with the rotation of the span, so that, with an angular movement of 80 deg.—the maximum allowable—the centres of the rollers will be 12ft. 6in. from the starting position. The mechanism will be operated electrically by means of three-phase, 50-cycle, 415-volt alternating current. The gates and other moving portions will also be controlled electrically and interlocked with each other and with the signalling system. The operating cabin is to be placed in such a position that the attendant may have clear views both up and down stream and along both road and railway.

As will be seen from the cross sections, the railway, which is to have two tracks arranged at 12ft. centres, is to be below and the roadway above, the height from rail level to the crown of the road surface being 27ft. The rail level will be 33ft. above high water level. The rails will be carried on transomes supported on an open deck steel floor system, and road on the fixed spans will be of reinforced concrete 22ft. 6in. between kerbs. On the lifting span there is to be a timber floor, and the width between kerbs will be 20ft. 3in. There are to be no footways at the road level, but a footway 5ft. wide will be arranged on each side of the bridge at rail level. These footways will be carried on steel cantilever brackets.

The road is to be diverted so as to clear the railway at each end by means of skew spans about 100ft. long, and will descend by means of viaduct and embankment on a 1 in 25 gradient to ground level. The length of the approach at the northern end is to be about 12 chains and at the southern end about 3 chains.

American Engineering News.

Large Earth Dam.

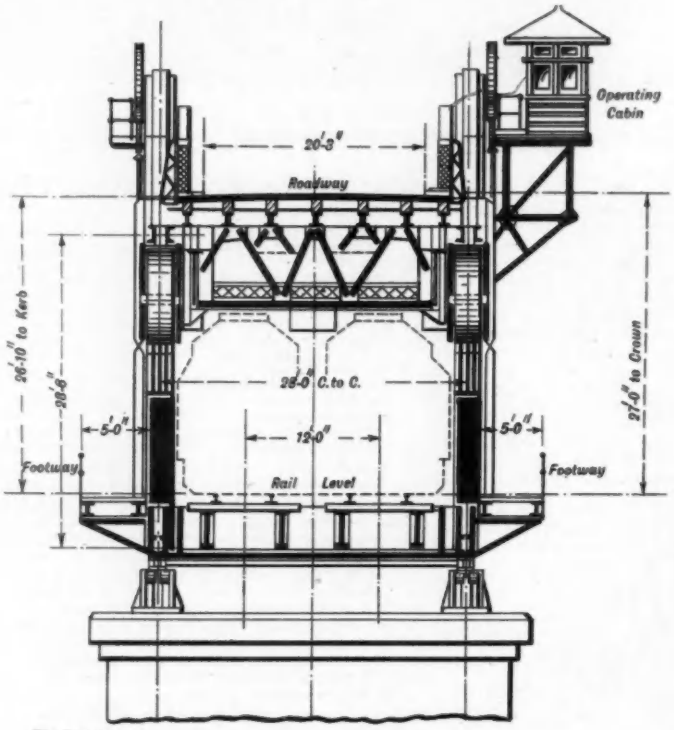
An earth embankment dam now under construction on the Saluda River in South Carolina will be the largest of its type ever built, being 7838ft. long on the crest, 208ft. high, and containing about 11,000,000 cubic yards of material. Its 25ft. crest will have a 20ft. concrete roadway and its maximum base width will be 1150ft. This dam will form a lake or reservoir for a hydro-electric development, the lake being about 40 miles long and 14 miles wide, with a water content of 2,500,000 acre-feet. The power plant will have four turbines of 50,000 H.P. each, with two more to be added later, working under a head of 165ft. average and 183ft. maximum. Each generator is of 32,500 kW capacity. The upstream slope is 3 horizontal to 1 vertical, and the downstream slope 2½ to 1. The spillway or waste weir will be a concrete dam, surmounted by four Taintor gates to maintain the reservoir at normal level. Four steel pipe lines 16ft. in diameter extend through the dam to serve as penstocks and are surrounded by concrete on which large collars are formed to check any leakage along the pipes. A semi-circular arch conduit of concrete provides for the two future pipes. Water is admitted by gates in an intake tower, and just before entering the power-house each pipe has a vertical surge tank of one million gallons capacity with its top 215ft. above the pipe. The riser or vertical pipe from the penstock to the tank is 14ft. in diameter.

Diverting a Large River.

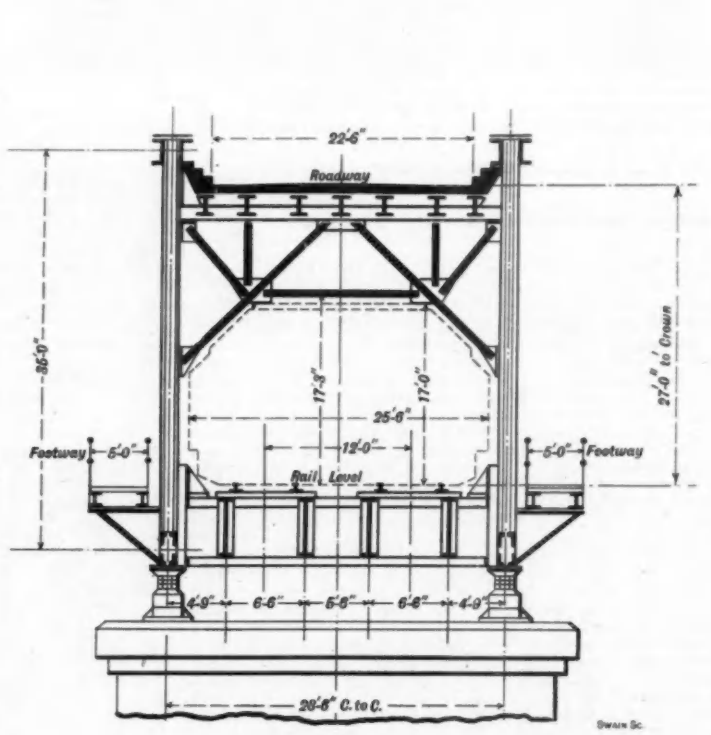
Although the city of Freeport, Texas is a seaport, it is 6 miles from the deep water of the Gulf of Mexico and is situated on the Brazos River. Navigation is hampered and sometimes interrupted by shoaling caused by the great quantities of silt brought down by frequent floods. Continual dredging would be enormously expensive and would only reduce the periods of obstruction without eliminating them. As a permanent remedy a new and direct channel for the river is being dredged from a point above the city to a new outfall some 6 miles from the river mouth. With the completion of this diversion channel the natural river course will be closed by a dam consisting of steel sheet piling and an earth embankment, with revetment on the upper side. This old channel will then become an estuary of the Gulf and will be deepened and straightened to improve navigation. A lock or a conduit with gates in the dam will permit of discharging water into the upper end of this estuary if desirable. The new channel, to carry the normal flow of the river, is 250ft. to 450ft. wide on the bottom, with 14ft. of water. But parallel with it will be broad earth dykes about 2000ft. apart and 12ft. high, the enclosed space forming a floodway to carry the flood waters. Its capacity will be more than 70,000 cubic feet per second, with 4ft. of freeboard on the dykes, while the heaviest known floods are less than that.

Railway Portable Laboratory.

As there are eighty steam power plants on the 12,500 miles of the Atchison, Topeka and Santa Fé Railway system, which consume the equivalent of 466,000 tons of coal annually, at a cost of £265,000 and an annual operating charge of £408,000, it is important to effect a closer control of operating economy than can be obtained by ordinary plant records and occasional inspections. For this purpose a car has been fitted up as a power-plant testing laboratory, with office facilities and living quarters for two men. For boiler tests, there are four recording units with charts, showing steam flow, CO_2, flue-gas temperature and feed-water temperature. The flow meters have integrators to show cumulative readings. Recording draught gauges, pressure gauges, water and oil meters and indicating thermometers are included in the boiler-room testing equipment. For plants using natural gas as fuel there is a gas calorimeter of the continuous flow type, and a gas density balance. For the operation of the flow meters there is a three-unit motor-generator set. Some of the apparatus is mounted permanently in the car, but other parts are carried into the power station and mounted temporarily, suitable connections being provided, so that the instruments can be attached with little trouble and delay. The installation of apparatus is done with the help of the shop force, and where there are shop apprentices they assist in conducting the tests and working out the results. In one year about a dozen plants were tested in this way. These plants range from 1500 lb. to 90,000 lb. of steam per hour; thirty burn coal, forty burn oil, and ten burn natural gas. The larger units supply alternating-current, direct-current, compressed air, water and steam for the railway shops.



CROSS SECTION OF BRIDGE AT LIFTING SPAN



CROSS SECTION OF BRIDGE AT FIXED SPANS

Electrically-operated Rod Mill.

At a steel works having rods as the main output, electric motors have superseded the former steam engine. Ingots of open-hearth steel, 18in. by 20in., are reduced in a steam-driven blooming mill to billets about 4in. square, which are delivered to the rod mill, which has six 16in. roughing passes and twelve 12in. finishing passes. The draught is heavy, as the ninth passes reduces the size to about ¼ square inch. Originally one engine was connected directly to the six roughing stands, another had a rope drive for ten stands, and the third engine had direct drive for the last two finishing passes. Now a 1750 H.P. synchronous motor drives the lay shaft of the six roughing

passes, the motor speed of 514 revolutions being reduced to 64 revolutions for the shaft. No. 7 pass is driven at 86 revolutions by a motor-generator set with 2100 H.P. motor; a 1750 H.P. motor drives Nos. 8, 9 and 10; one of 1300 H.P. drives Nos. 11 and 12; a fifth of 2750 H.P. drives Nos. 13 and 14; and Nos. 15–16, at different speeds through reduction gears. All of these are synchronous motors, while a 1200 H.P. direct-current motor served by the motor generator set drives the two final passes Nos. 17 and 18. This is believed to be the first installation of a set of synchronous motors for group drives, and it has another feature of interest in the combination of a direct-current generator with a synchronous motor to form a motor-generator unit serving a direct-current motor for two finishing stands. All the motors, except the 2750 H.P. unit, are arranged to start on full voltage. The power consumption is about 200 kilowatt-hours per gross ton of product, as against 13,000 lb. of steam per hour, besides which there is a great reduction in labour for operation and maintenance.

Electrically Welded Pipe.

Production of 8in. to 28in. pipe in 30ft. and 40ft. lengths at the rate of 26 miles per 24-hour day, at a large pipe mill, is effected by special arc welding apparatus, automatic conveyors, testing machines, and mechanical handling devices, which reduce manual labour to a minimum. The skelp or plate, ¼in. to ½in thick, is delivered in lengths and widths to make pipe of certain sizes. Its carbon content is 0·25 to 0·30 per cent., and the minimum tensile strength is 60,000 lb. per square inch. After being pickled and cleaned to remove mill scale, the skelp is passed through a series of operations in hydraulic presses to form pipe of the desired diameter. Numerous parallel conveyors deliver these cylinders to the automatic welding machines, which weld the butt joints as the cylinders pass through. The welded pipe is then taken by another conveyor to a milling machine, which trims off the welding bead for a sufficient distance at each end to allow of making the joints. For bell-and-spigot pipe one end is expanded cold to form the bell, and a bead is upset on the other end. The welded pipes are then run back to a row of hydraulic testing machines, where a pressure sufficient to produce a stress of 22,000 lb. per square inch is maintained for ten seconds, while a series of hammers deliver blows upon the weld. The pressure is then reduced while the outer length of the weld is examined. After being warmed the pipe passes through a paint spray and then to storage racks, from which it is loaded into railway wagons by a final set of conveyors.

SIXTY YEARS AGO.

IN the late 'sixties of last century the construction of a tunnel beneath the Straits of Dover or the carrying out of some alternative scheme—as by means of a bridge or an embankment—of improving transport facilities between England and France seemed to many people in both countries to be within reasonable bounds of being accomplished in the near future. Many schemes, most of them patently absurd or impracticable, were advanced, and the acrimony aroused by the debate of their relative merits led us at one time to place a check on the freedom of correspondents to discuss the subject in our columns. By 1869 a large section of the engineering public was heartily tired of the question. Occasionally, however, reputable engineers would advance their views on it and to them we gave full publicity. When, for instance, Mr. J. F. Bateman and Monsieur J. J. Révy described to the British Association a proposal for the laying down of a cast iron tube railway on the bed of the sea between Dover and Cape Grisnez, we reprinted their paper almost in full, and in the same issue—August 27th, 1869—commented upon the scheme in a leading article. Mr. Bateman and Monsieur Révy proposed that the tube should be constructed in sections, 10ft. in length, flanged and bolted together, lined with brickwork internally, and protected on the outside by bricks, cement and a wrought iron skin. The tube was to rest directly on the bed of the channel and to follow its contour, piles being driven beneath it where necessary for its effective support. The laying of the tube was to be accomplished within a cylindrical bell fitting over its advancing end, and pushed forward from time to time as the laying proceeded. We did not comment on the technical features of the scheme, but gave it prominence solely because it was Mr. Bateman's, and because, so it can be inferred, it gave us an opportunity of discussing certain aspects of the Channel Tunnel scheme in general which, we said, had so far been given insufficient attention. Our comments were adverse to the commercial results likely to be derived from the tunnel. The cost would, we said, be anything from ten to twenty million pounds. Was the difficulty of crossing a poor twenty miles or so of water so great that two nations, in order to get rid of it, should be content to pay by way of interest £350,000 to £700,000 a year between them? We did not think that the traffic using the tunnel would pay a good interest on the cost of construction, and in that view were supported, we pointed out, by the opinion expressed by a Commission appointed by the Emperor of the French to study the problem. All the traffic then being carried between England and France had been insufficient to prevent the South-Eastern Railway from becoming bankrupt, and the London, Chatham and Dover Railway from reaching the verge of bankruptcy. It was most unlikely that it would prove remunerative to spend ten million pounds on a scheme that would substitute a run of forty minutes through a tunnel for a run of eighty or ninety minutes on a steamer. If the tunnel were constructed a competition of cheap fares would set in between it and the steamers, and the steamers we were certain would win. Would the prospect of running through a twenty-mile tunnel induce travellers to give up going by sea? Could the tunnel possibly accommodate the number of trains required to make it pay? Could it look to the transport of goods as a means of supplementing its receipts from passengers, and if it could do so, could it hope to compete against the rates charged for sea-borne cargoes? Metaphorically we shook our head in reply to all these questions. To-day we are in no better position to answer them, although they have as much bearing on the subject now as they had then.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Position Unchanged.

THE quiet conditions ruling in the Midland and Staffordshire iron and steel trades during the past two weeks have not been disturbed since I last wrote, and what I reported in my letter a week ago applies equally well to-day. The seasonal slackness is not greater than that usually experienced at this time of the year. It is too early as yet to expect any development of the autumn demand. Some inquiries are in circulation relative to supplies of iron and steel for the last quarter of the year, but they are purely tentative. Material required for immediate consumption is being bought in small tonnages, the full market price being, in most instances, paid. There has not been a large addition to the volume of orders on iron and steel masters' books at the beginning of the month. Production is maintained, however, at about the recent level.

Pig Iron.

Current demand for pig iron is quiet, but specifications against contracts continue to come in with regularity and output is not permitted to outrun demand. Not more than one-fourth of the furnaces in the Staffordshire, Worcestershire and Shropshire area are in blast, and only about half of the number in Derbyshire and Northamptonshire. Nor is there any talk of recommissioning idle furnaces at present. A strong market tone exists, and prices are firmly held. With a quiet market on one hand, and hardening terms for furnace coke on the other, smelters are certainly worried, but they are in no wise inclined to test the possibility of reinvigorating demand by offering supplies at lower rates. Present selling prices, they assert, do not leave a large margin of profit, and production during some months of the year was made at a loss, so that there is ground to be made up if they are to finish the year satisfactorily from a financial point of view. In the course of the next few weeks many contracts will be due for renewal, and present indications point to a maintenance of current selling rates. These are based on No. 3 foundry qualities, £3 16s. for Derbyshire, and £3 12s. 6d. for Northamptonshire, delivered Black Country stations. There is no improvement in the coke position from the blast-furnaceman's point of view. Values remain high at 16s. 6d. to 17s. per ton, and early delivery of orders placed now are difficult to obtain. Ovenmen adopt an independent attitude when approached regarding end of year supplies. Trade in hematite iron in this district is quiet just now. Values are unchanged, East Coast No. 3 being quoted £4 10s. 6d. to £4 12s. 6d., and West Coast, £4 12s. to £4 13s. 6d. per ton.

Steel.

The steel industry in this area proceeds steadily, and hopes of much increased business in the near future are expressed. Structural engineers in particular are hopeful, the various projects known to be pending leading them to anticipate improved business. Finished steel prices are unchanged, angles making £8 2s. 6d.; tees, £9 2s. 6d.; joists, £8 2s. 6d.; ship, bridge and tank plates, £8 17s. 6d.; boiler plates, £9 12s. 6d. upwards. Staffordshire steel hoops are £10 at works. Continental competition in the half products department continues unabated, but sellers do not appear to be making much headway. This week imported billets have been offered at £5 15s. for 2in., and £5 12s. 6d. for larger sizes. Foreign bars could be had at £6 15s. Native makers of billets want £6 10s. upwards for their output, while re-rollers of bars, though they ask £8 5s., would, it is asserted, be prepared to do business at £8 2s. 6d. if not at less. A firming up of foreign prices would be welcomed by native steelmasters, who are feeling the severity of the continental competition and realise that as the disparity between the English and foreign quotations increase, so their chances of obtaining large business decreases. Every effort is being made by Midland steelmasters to keep orders from going abroad, but they are quite unable to accept business at the prices considered satisfactory by continental producers.

Finished Iron.

There is little, if any, change to report on the week in the Staffordshire finished iron trade. Orders continue to be received by makers of both best and merchant grade iron, but selling prices are such as to provide only small remuneration. Raw material costs have advanced to such an extent that an advance in finished iron prices in the near future is almost a foregone conclusion. At date recent prices are maintained, but when ironmasters meet in September they are expected to revise them. Staffordshire marked bars sell at £12 per ton, Crown bars £10 upwards, nut and bolt and fencing bars £9 5s. upwards, wrought iron gas tube strip makes from £11 to £11 2s. 6d., according to the size of order. The Staffordshire mills are not by any means fully employed, but regular rolling programmes are maintained.

Demand for Strip.

Increased inquiry for tube strip, both iron and steel, is reported this week. Since just prior to the August holidays business, after being brisk, has fallen away, and this renewal of buying is very welcome, signifying, as it does, increased activity at the tube works. British steel strip is selling at round about £8 per ton. Continental makers are competing keenly for the business, and offer strip at about £7 5s. It is claimed by users that they can buy at an even lower figure. A fair amount of business is said to have gone to the Continent, but local steelmasters have also added to their order books. Wrought iron tube strip sells steadily, prices ranging from £11 to £11 2s. 6d. being paid for this material. There is a tendency for the lower figure to disappear, as producers' order books become more bulky. Ironmasters hereabouts are pleased with this branch of the trade, which is just now the most active section.

Galvanised Sheets.

The demand for galvanised sheets is poor. The autumn reinvigoration is not yet evident, and the inquiries in the market are not such as to justify rollers in departing from the basis price of £13 7s. 6d. per ton for 24-gauge corrugateds. It is extremely probable, however, that at the first sign of awakening demand prices will be advanced. The bars used in the trade now cost £6 5s. for native makes and £5 17s. 6d. to £6 for bars of foreign manufacture.

Scrap.

There has been no change in the situation in the scrap market during the week, and values remain somewhat unsettled. Birmingham merchants' quotations vary between £3 16s. and £3 17s. 6d., but this does not necessarily represent the selling figure, which depends to some extent upon the specification and the relations existing between the consumer and the merchant. There is now no shortage of supplies.

Furnace Coke.

There is no easement in the furnace coke situation. Midland blast-furnacemen have to pay 16s. 6d. to 17s. per ton at ovens for fuel bought on the open market, and smelters inquiring regarding contracts find contract rates are undergoing a corresponding advance. Under these circumstances they refrain from placing orders, hoping for better terms before existing contracts terminate. As more coking coal becomes available larger demands are being made upon the coke supply for central heating and other winter uses. The possibilities of bringing more coke ovens into operation are limited, so that developments are being watched with some anxiety.

Unemployment.

A substantial decrease in the number of unemployed in the Midlands area was shown by the latest returns. The total fell from 183,781 to 171,357, giving a reduction on the week of 12,424. In the detailed returns for the principal towns there are many decreases, but slight increases were reported from Birmingham, Leicester, Peterborough and Smethwick.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Steel in Coal Mines.

FROM the point of view of safety in mines in the Lancashire, Cheshire, and North Wales coalfields, a strong case for the wider employment of steel for various purposes has been prepared by the Support of Workings in Mines Committee in a special report issued this week. So far, steel props in this part of the country have received only a limited trial, and the Committee recommends that underground trials on a much more extensive scale should be made. In other areas where they have been used there has been a marked reduction of accidents resulting from roof falls, coupled with a reduction of the cost of supporting the roof. It has also been found that coal mines in the districts covered by the report have made very little use of steel arches, and that no colliery has adopted these for the normal means of support or for regular use near the face of future main roads. The Committee stresses the fact that in most other coalfields the value of steel arches, from the point of view both of safety and economy, is now recognised, and that their use is being extended. More especially in the case of props, it is pointed out that the relatively high initial cost of steel is often saved in the space of a few months.

Noisy Tramcars: A Diagnosis.

Mr. F. Stuart Pilcher, who was recently appointed general manager of the Manchester Corporation tramways undertaking, has taken the problem of noisy tramcars very much to heart, and has prepared a special report on the subject. This was considered by the Tramways Committee at a meeting on Tuesday of this week. The large double-bogie tramcars used in the city weigh about 14 tons each, and, largely in consequence of the fact that rough paving is still widely used here, they cause much more noise than four-wheel cars. Mr. Pilcher diagnoses the causes of the noise as follows:—Corrugations on rails, worn crossings and junctions, rattling chains on bogies, chattering chain blocks, loose motor case lids and gear case lids, loose motor suspension springs, howling gears, and "jazzing" of cars when at high speeds. Having diagnosed the trouble, Mr. Pilcher sets forth his remedies. Corrugation of rails is being removed at nights and worn crossings are being repaired by electric welding plants, though some months will elapse before the whole of the worn crossings can be dealt with. The chains, which are fitted to minimise the danger of accident in case of a car leaving the rails, are being replaced by steel checks, work which is expected to take about eight months to complete. A new type of brake is being fitted, and loose motor case lids have now all been remedied. Attention to motor suspension springs will probably take about twelve months.

Ironworks to Close.

The directors of John Summers and Sons, Ltd., of Shotton, near Chester, have decided to close down the sheet metal mills and the galvanising departments at the Globe Ironworks, Stalybridge, near Manchester. These comprise much the greater part of the works, and about 800 men will be out of work in consequence. The present arrangements are that the sheet metal mills will close in about a fortnight's time, when the present stocks will have been used up, and the galvanising department about a week later. Employees in these departments will be given the opportunity of working at the Shotton plant as vacancies

occur. The hoop mills and the nail works at Stalybridge will continue to run as usual. An attempt is being made by the Mayor of Stalybridge to induce the directors of the company to reconsider their decision, but with what effect is not known at the time of writing.

Town Hall Extensions.

Extensions to Manchester Town Hall have been under discussion for several years, but the first practical steps were taken at the beginning of this week, when demolition work was commenced on property lying between Lloyd-street and Peter-street, and covering a very wide area. The first part of the work, affecting an area of about 3400 square yards, is to be completed in twelve weeks. It will entail the removal of about 15,000 tons of material of various kinds. The extension scheme will probably be the biggest of its kind ever undertaken here, and large quantities of steel and other constructional materials will be necessary. So far as is known, however, no contracts for these have yet been placed.

Floating Whale Factory.

The "San Patricio," formerly an oil tanker, has been under reconstruction at the Birkenhead yard of Cammell Laird and Co., and, as the "Southern Princess," sailed from the Mersey this week for the Ross Sea whaling grounds. The vessel, of about 7350 tons, is now a self-contained whale oil factory, owned by the Southern Whaling Company, Ltd. She has a carrying capacity of 75,000 tons of whale oil, and is fitted with blubber butts, packing machines, and settling tanks. The plant will be able to extract about 1500 barrels of oil a day, compared with about 70 barrels in three days by former whaling vessels.

Non-ferrous Metals.

Rather mixed conditions have obtained in most sections of the non-ferrous metals market during the past week, and lead provides the only instance where values have advanced above the levels ruling a week ago, copper, tin and spelter all showing declines of varying extent. Buying interest in the case of copper, particularly from speculators, has been less in evidence, and the aggregate turnover in standard brands has been on a smaller scale than in the previous week. The demand for refined descriptions also has been very moderate. These have been maintained at recent levels, but some reaction has occurred in standard metal, quotations current at the moment of writing being about 5s. a ton lower on balance for the week. Tin, likewise, has weakened, in this case to the extent of between £1 10s. and £2 a ton, according to position, prices having more than lost the whole of last week's advance. There has been a fair turnover, however, and the market view at the moment appears to be opposed to any marked renewal of weakness, such as was experienced before the turn of the half year. Lead has met with a moderate demand, and prices in this section have continued their ups and downs, the previous week's loss having been recovered. Weakness is still to be reportéd in the spelter section, and relatively heavy supplies of the metal have been accompanied by a loss of several shillings a ton on the week.

Iron and Steel.

Except for a firming up in quotations for Scottish brands of foundry iron and the possibility of a resumption of premium prices in the case of certain Derbyshire producers, there has been little in the way of developments on this market since last report. Contract deliveries to Lancashire users are still reasonably good, considering the time of the year, but new buying this week has been very slow. Offers are firm generally, with Staffordshire at 75s. 6d., Derbyshire at 74s. 6d., Middlesbrough at about 86s., Scottish at up to 93s. 6d., and West Coast brands of hematite iron at 87s. 6d. per ton, including delivery equal to Manchester in each instance. A quiet business is being done in bar iron at £10 15s. per ton for Lancashire Crown quality and £9 15s. for seconds. The steel market this week has been characterised by pronounced weakness in several sections of the market for continental steel, with British prices firm generally. A fair aggregate trade is being done in constructional kinds, and also in locomotive materials, largely against old contracts. The reductions in foreign steel have resulted in rather more buying than has been witnessed for some time. Imported steel bars are now at about £6 12s. 6d. per ton, joists at £6 5s. to £6 6s., angles at £6 7s. 6d. to £6 12s. 6d., Thomas plates at £7 6s., billets at £5 7s. 6d. to £5 10s., according to size, and sheet bars at about £5 10s., including delivery to buyers' works in the Lancashire district.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron market continues to show strength, and makers are fairly well fixed for contracts for practically the whole of this year. The fact that steel is in little demand will mean that there is more iron available, as in the case of Barrow where the rail mills have stopped. This may mean more business abroad. There is a tendency for prices to stiffen, as it is claimed that present rates do not allow of much margin to the producer. It is argued that West Coast hematite is too cheap at present, compared with East Coast prices. American and continental business is maintained, and there is a possibility of this trade increasing. Iron ore remains about the same, with fairly good demand from the outside, particularly Scotland and the East Coast. The steel trade is very dull. Few orders are about, and competition continues to be keen. It is impossible to say how long the works will be closed down. At Workington the steel works are closed this week, but contracts are held which allow of three weeks' running out of four. The hoop mills at Barrow are well situated for orders, and are assured of constant running. Steam coal is easier, but, on the other hand, East Coast coke is up in price, and that may be the determining factor in the fixing of future prices of pig iron.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Conditions.

ALTHOUGH there is no great activity in the steel trade generally, a feeling of optimism prevails so far as the future of many departments is concerned. Slackness is worst in the heavier branches, and for ordinary lines there is still only a poor demand. But the satisfactory feature of the position is that improvement is noticeable in the market for special steels needed for modern industrial purposes. The outlook in this direction is good. Quietude continues in the departments which deal with railway material, although there has been a slight increase in orders. Acid steel is also quiet, but basic steel is in satisfactory demand, and the great plant at Templeborough—where nine of the thirteen Siemens' steel furnaces are in commission—has had some huge outputs recently. The continuous mills there, both rod and strip and bar, are also working well. In North Lincolnshire, too, there is considerable activity, and prospects are encouraging.

Tramway Trackwork.

Many cities and towns in the country have recently altered their tramway systems, and introduced trackless traction. This tendency is having a serious effect upon a branch of industry which has been a monoply of Sheffield firms for a considerable time. There has been a very noticeable falling off in orders for tramway trackwork, points and crossings, lay-outs, &c., in the manufacture of which manganese steel is extensively used. As works have been specially equipped for the production of this class of work, the importance of the position can be realised. The loss of orders through the introduction of trackless trolley vehicles is indeed becoming a serious matter. A large mill which formerly rolled many thousands of tons of rails for British tramways has had to be closed. But the position is not entirely unexpected, as the advantage of transport systems which are not confined to rails is realised in these days of traffic congestion, and in addition it is pointed out that tramway rails to-day cost about three times as much as they did when the electric tramcar became a common vehicle, whilst the cost of labour employed in laying a track is now also a much bigger item. Considerable consolation can be obtained from the fact that many orders are being received locally for special parts, springs, &c., to be used in the omnibuses and other vehicles which are superseding the electric tram. This class of work and the number of orders for parts for different types of motor cars are growing rapidly, and the welfare of Sheffield trades is now closely bound up with the prosperity of the motor industry.

New Uses for Steel.

As previously indicated, it is with the new and special lines of steel that most progress is being made. In this connection, it is interesting to note that the United Steel Companies, Ltd., have taken orders for 5000 tons of steel sleepers for the Southern Railway, 10,000 steel sleepers for the L.M.S. Railway, and a trial order of 500 tons for the L. and N.E. Railway. Sheffield specialises more, however, in steels of higher quality than that used in the manufacture of sleepers. Stainless steels, for instance, are being adapted to many new uses, one of the most recent of which is in the construction of aeroplanes. The non-corrosive quality is, of course, of great value for aircraft work, but the non-magnetic type of stainless steel is finding an increasing application in this class of work because where earth inductor compasses are installed the non-magnetic feature is essential. Recently stainless steels have been used in the manufacture of aeroplane ribs, special brazing and welding processes being used.

Production Figures.

It is not generally realised that the production of 804,000 tons of steel in this country during last month was considerably more than the monthly average of the boom year of 1920. The figure was 26,000 tons less than in June, however, and 40,000 tons less than in May. Attention will be paid to the fact that Pretoria, South Africa, is to have a steel plant of 200,000 tons annual capacity, laid out according to the best American and European practice. This will be complete from coke ovens, blast-furnaces and open-hearth furnaces through to the rolling mills, and the works will be constructed under the direction of the International Construction Company, Ltd., of London.

Famous Works to Close.

The decision has been made that in the near future the works of Henry Bessemer and Co. Ltd., Carlisle-street, Sheffield, will be closed. Operations previously carried out in these works are to be transferred to the Kilnhurst works of J. Baker and Co. (Rotherham), Ltd., which firm recently absorbed that of Bessemer and Co. Special interest attaches to the matter in view of the fact that it was at the Carlisle-street works that the late Sir Henry Bessemer, in 1856, first demonstrated the commercial value of his famous process. That process brought a world-wide reputation to Sir Henry and his firm. The works, the closing of which is said to be inevitable, have two open-hearth melting furnaces with mills and forges where steel forgings, axles, and tires for railways have been the principal products. Another well-known Sheffield factory—the Emu Works, Eyre-street—has just changed hands. This was erected about 1820 at an estimated cost of £30,000, and equipped for carrying out every process connected with cutlery manufacturing and silversmithing. Recently the new grinding regulations caused many men employed at the Emu Works to become unemployed, but the establishment has now been purchased by Dr. G. H. Froggatt, a local Councillor.

The Lighter Trades.

The demand for cutlery and plate is not so good as it was in the corresponding period last year. One satisfactory feature, however, is the better call from Australia and New Zealand for Sheffield cutlery. Most of the articles exported to these Dominions are of the cheap type, but the market is fairly substantial. Some of the firms manufacturing silver and electro-plate report better business, and in view of the slackness of some works, particularly those of small size, it is significant that Mappin and Webb, one of the biggest firms in Sheffield, have just reported a record year. There continues to be a steady improvement in the demand for tools, except farm and garden implements.

New Industry for Doncaster.

A site of 77½ acres at Wheatley, Doncaster, has been acquired by British Bemberg, Ltd., the British branch of the large German firm of artificial silk manufacturers, and it is proposed to erect a factory where it is expected 5000 persons will be employed. The process to be used at the new works differs from the two other main processes used in the manufacture of artificial silk. The Bemberg Company's process has as its principal raw material the short fibres shaved off the husks in which cotton used in Lancashire is enclosed. The exact treatment is a secret, but copper salts, ammonia, and other chemicals are involved in it. A large supply of water is required, and special bore-holes are to be sunk. One of the main reasons for the selection of Doncaster for the new industry was that plentiful supplies of water are available.

Rural District Schemes.

Having failed to come to terms with the Donnington Waterworks Company for the purchase of its undertaking, the Boston Rural Council has sunk trial bores in Quadrin Fen and has tapped a supply of pure and wholesome water. A scheme is to be submitted to the Ministry of Health for the supply of water to a large district south of Boston. Ratepayers at Hunmanby, Yorks., have expressed approval of a scheme of water supply for Hunmanby, Barton Row, and Primrose Valley, at a cost of between £10,000 and £11,000. The Doncaster Rural District Council has applied to the Government for sanction to borrow £19,995 for the purpose of sewerage and sewage disposal works at Armthorpe, a village which has developed greatly since 1919, when a colliery was sunk there by the Markham Main Colliery Company. The Bridlington Town Council has given approval to a scheme presented by the Electricity Committee for a change over from the present direct-current system to alternating current. It is hoped to effect the change in 1930 or 1931, and the total estimated cost of the scheme is £41,890.

Torksey Bridge Foundations.

Trouble is being experienced with the foundations of the new bridge over the Fossdyke at Torksey, Lincolnshire. A slight settlement has been found, particularly under the north pillar, and a crack has appeared above the archway. Considerable difficulty was experienced when the present foundations were put in, with the result that although it was expected that the bridge would be completed in just over a year, the operations occupied nearly three years.

NORTH OF ENGLAND.

(From our own Correspondent.)

Better Trade.

THE iron and steel industries in the North of England are gradually assuming a more prosperous condition, and preparations are being made in many directions to increase outputs. This week Gjers, Mills and Co., Ltd., have put another furnace into operation at their Ayresome Ironworks, Middlesbrough. The furnace will begin on ordinary hematite, but it is intended to go on to special iron. This is the third furnace rekindled this year at the Ayresome Ironworks. For a year the works were idle in every department, but in January last the first wave of returning prosperity was experienced, and two of Messrs. Gjers' furnaces were lit. Two idle furnaces at the Seaton Carew Works are expected to be rekindled next month. Of the ninety-five blast-furnaces built on the North-East Coast, forty-seven are at present producing iron. Of these, nine are making Cleveland pig iron, fifteen are running on hematite, and twenty-three are manufacturing other kinds of iron. The statistical state of all branches of the iron and steel industry is healthy. There are no heavy stocks to hamper business, but consumers show reluctance to follow the movement towards an advance in prices, while cost of production is rising and raw materials are becoming dearer.

Cleveland Iron Trade.

Holiday influences are still interfering with the Cleveland iron market, and no substantial transactions are reported. The ironmasters, however, are not disturbed about the disposal of their output. They have very little foundry iron to sell earlier than October, and this will find ready buyers. The makers' real trouble is that costs continue to advance, and what would have been a profitable figure a couple of months ago leaves no margin at present. Coke is dearer, and it is only because producers have old contracts for raw materials at lower prices that they can afford to sell at current quotations. Thus buyers have no real hopes of cheaper iron, and it is expected that they will soon be coming along to cover heavy autumn requirements. Meanwhile, prices are unaltered, No. 1 Cleveland foundry iron being 75s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; and No. 4 forge, 71s.

Hematite Pig Iron.

Better accounts are given of the East Coast hematite pig iron trade. Prices are gaining strength, but manufacturers are still unable to secure orders except on unremunerative terms, and progress towards an economic level is slow. Fairly good home and continental inquiries are circulating. Prices paid vary after individual

bargaining, but 75s. 6d. to 76s. for ordinary qualities may be given as the basis of quotations.

Ironmaking Materials.

Recent unloadings against running contracts have provided ample supplies of foreign ore. Consumers are heavily bought up to the end of next year, and as merchants are unable to offer parcels of any size except for delivery well ahead, very little new business is passing. Consumers are not at all disposed to pay the rates demanded, which are at the equivalent of best Rubio at 24s. 4d. c.i.f. Tees. The situation as regards Durham blast-furnace coke is causing some anxiety. Local requirements continue to increase, and production threatens to be inadequate, notwithstanding a forthcoming enlargement of output. Good medium qualities command 22s. delivered at North-East Coast works.

Manufactured Iron and Steel.

Manufactured iron and steel firms are well placed as regards orders, and hope to make further substantial contracts in the near future. Demand for semi-finished steel is quieter, and continental competition is increasing, but producers have a lot of work to execute. Indication of an early expansion of transactions in finished steel is noticeable. Prices are unchanged.

The Coal Trade.

A substantial inquiry for all descriptions of coal for shipment during the remainder of the year is circulating in the Northern coal trade. One of the most important is the inquiry from the Swedish State Railways' administration, which is seeking offers of 65,000 tons of steam coals, preferably Northumberland or Durhams, but shippers have the option of tendering for Yorkshire or Scottish coals. Shipments are spread over the remainder of this year. North of England merchants are in a quandary, as tonnage supplies remain scarce, and with no prospect of any increase for weeks ahead, the quotation of c.i.f. prices is rather hazardous. This difficulty also occurred in the case of the Westeral Railways, which recently sought offers of Newcastle coals, but the c.i.f. prices turned the scale, and the order went to Poland at prices two or three shillings below British tenders. Another inquiry on the market is from the Finnish State Railways for from 30 to 50 thousand tons of steam coals for shipment during the present season. The pressure for Northumberland steam coals is maintained, and fitters of all descriptions report being oversold and heavily stemmed. New business is confined to cargoes thrown on to the market by tonnage falling back. There are no quotable changes in steam coal values. Best large kinds remain at 15s. 9d. to 16s.; Tyne primes at 15s.; and seconds at 14s. 6d. to 14s. 9d. Small steams are unchanged at 10s. to 10s. 6d. for bests or specials, and 9s. to 9s. 6d. for second qualities. These prices are easily realisable for prompt and also next month. In the Durham market, individual colliery positions vary, but in the main there is still quietness for this week. There is good business in gas coals, and prices are well maintained for bests at 16s. 9d. to 17s., and Wear specials at 17s. 6d. to 18s. Second gas fuel is obtainable at 15s. 6d. to 15s. 9d. Durham steam coal is at 18s. for large and 12s. 6d. to 13s. for smalls. Bunkers remain at 16s. 9d. to 17s. 3d. for bests and superiors, and 15s. 6d. is now the general figure for ordinary grades. The undertone of the coke market is strong. The current output of all grades of cokes is readily snapped up, and the autumn demand shows increasing volume, and prices are quoted firmly. Gas coke is 21s. 6d. to 22s.; beehive cokes, 30s. to 32s.; patent oven cokes, 23s. to 24s.; and superior qualities, 27s. to 28s.

Ironstone Miners' Wages.

Cleveland ironstone miners and associated limestone quarry workers have formulated proposals for higher base and tonnage rates with the object of obtaining increased wages for datal and piece workers. The proposals are to be submitted to the owners with a request for an early joint meeting.

Order for Wear Firm.

J. L. Thompson and Sons, Ltd., of Sunderland, have received an order for a vessel of about 6500 tons deadweight carrying capacity for Headlam and Sons, Ltd., of Whitby. It is understood that the engines are to be constructed by a Wear firm.

SCOTLAND.

(From our own Correspondent.)

Steel.

THE position in the steel trade on the whole is unchanged. In some districts the works are comfortably placed, but owing to the irregularity of the general demand, others find difficulty in maintaining even a moderate degree of employment. For some time orders for plates and sections have been below normal, but there are prospects of better orders from the shipbuilding yards, and the outlook may therefore be pronounced more favourable. The improvement may be hastened if latest advices in respect to continental competition are borne out.

Steel Sheets.

Some expansion in the demand for sheets has been noted. Heavy descriptions still sustain keen competition, but the lighter gauges are comparatively busy, and inquiries are now more prolific. Galvanised sheets experience quieter conditions, but it is thought that this is only a temporary phase.

Tubes.

Apart from a slackness in demand for butt-welded descriptions, tube makers have nothing to complain of, most departments being well occupied and inquiries are promising.

Iron.

There is no apparent move in the iron trade, and most sections remain disappointing. Business on the whole is small and erratic, and makers find difficulty in maintaining employment. Bar iron prices for home delivery are fixed at £10 5s. per ton, which is lower than in some other districts, but the export quotation of £9 15s. per ton might perhaps be shaded somewhat if a good order was offered. The re-rolling department has been quiet for some time, but the higher trend of continental prices may work some improvement, especially if foreign "semis" appreciate also. Prices are unchanged at £8 per ton home and £7 15s. per ton export.

Scrap.

Supplies of scrap material are not too plentiful, and the level of prices is firmly maintained as follows:—Heavy steel, 76s. 3d.; heavy basic, 72s. 6d.; and cast iron machinery scrap, 70s.—all per ton.

Pig Iron.

Business in pig iron is quiet but steady. Demands from steel works have improved a little, while the turnover has declined a little in other directions. Prices are firmly maintained at the latest fixed minimum.

Coal.

The collieries in most districts are more or less fully booked up to the end of August, and any odd lots becoming available for prompt sale fetch full market prices. New business has been slow, but with collieries comfortably placed meantime the trend of prices has been upwards, owing to the scarcity of most qualities, and especially Lanarkshire splints and ells, and Fifeshire prime steams. The last-mentioned perhaps constitute the firmest feature of the market at present. Washed nuts, especially trebles and doubles, are also scarce and firmer. Aggregate shipments amounted to 288,201 tons, against 253,988 tons in the preceding week, and 230,070 tons in the same week last year. A firmer tone is noticeable in the home market also, and an advance of 1s. to 1s. 6d. per ton in household fuel will probably be announced within a few days. The Swedish and the Finnish State Railways are asking for tenders for supplies until the end of the year, and while Scottish collieries may be interested, only small portions of these contracts have come their way for some time.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

CONDITIONS in the steam coal trade are quiet and holiday-like, judging from all outward appearances. There is no indication of a burst of activity being imminent, and it is quite possible that present conditions will continue for another week or two, though so far as later in the year is concerned an optimistic view is entertained. Loading pressure at South Wales ports has certainly fallen off during the past week. It was scarcely expected that the position of a fortnight ago would be maintained for a very long period. The time has now arrived when once again the number of idle loading appliances exceeds the number of steamers waiting to berth. At the end of last week there were twenty-two idle appliances and seven waiting steamers. Tonnage arrivals over the week-end were disappointing, with the result that on Tuesday there was no variation of any material account in the loading situation. There was a marked improvement in shipments last week, as compared with the preceding week, the total returned being over 514,000 tons, as against just over 233,000 tons. The chief trouble of most colliery undertakings is that the demand for large coals is out of proportion to that for smalls and sized qualities. The latter descriptions are undoubtedly maintained at a relatively higher level, owing to the fact that production of large coals is interfered with by the curtailed outlet. Among the vessels at present in Cardiff are two ex-White Star liners which are engaged as oil refineries and coal depôts for fleets of whalers operating in the South Georgia whaling grounds. These vessels are taking 12,000 and 9000 tons of large coals as bunkers and other similar vessels are due to arrive shortly, it being estimated that the total quantity of Welsh coals which they will take will be in the neighbourhood of 100,000 tons, which, coming at a time when conditions in the steam coal trade are normally on the quiet side, is a very useful addition to business. Generally speaking, the foreign demand for coals is very featureless, but this is not expected to last long.

Pulverised Fuel.

Reference was made some weeks ago to the American Shipping Board steamer "West Alsek" being at Cardiff, where she took in Welsh and Forest of Dean coals, to be pulverised and used on the trip from Cardiff to Baltimore. News has now come to hand of the arrival of the vessel at her destination in three hours under fifteen days. The steamer travelled at the average speed of 250 miles a day, which was an increase of 10 per cent. on her previous normal speed. Rough weather was experienced during part of the trip, but, nevertheless, a record run of 258 miles was achieved on one day. It is stated that the results given by Welsh fuel were satisfactory throughout the voyage, the vessel steaming a knot faster than on any previous passage in her history.

Tin-plate Items.

For the past week or more labour troubles have been experienced at the Gorseinon Tin-plate Works, the result of the dispute which originated in the mill department being that more than 400 workmen have been idle. The stoppage is quite unconstitutional, and up to the time of writing efforts to bring about a settlement have failed. The trouble arose through the recent adoption of what is known as the three-part system in the mill department, and a difference regarding the division of duties among the men concerned. About 120 men ceased operations and caused unemployment for others. Until the men resume, the Joint Industrial Council cannot negotiate with a view to settling the points in dispute. A more interesting item is perhaps the fact that on Monday last the Briton Ferry Steel Company started one mill at the Old Margam Copper Works, Taibach, Port Talbot, for the manufacture of black tin-plate. About 80 men are to be employed immediately, but if the progress made is as anticipated, employment will be found for a much larger number of men. These works were at one time among the best known in Wales.

Current Business.

There is not much fresh business passing in steam coals. The main feature continues to be the strength of smalls and sized coals, which are practically on the unobtainable list so far as early shipment is concerned. Large coals are by no means so good, as the demand is far below the supplies of most grades, and, as a consequence, prices are on the minimum. Patent fuel manufacturers are well booked up for the works that are operating, and coke finds a ready outlet. The market for pitwood is also firm; in fact, it might be almost said that values are nominal. For prompt parcels sellers can no doubt get a shade over 40s., probably 42s. 6d., and there is no indication of the price easing for a little time at least. For collieries that have to make immediate purchases, the position is a rather serious one, pitwood forming the second heaviest charge on undertakings, and coming next to wages.

LAUNCHES AND TRIAL TRIPS.

PORTFIELD, steel screw steamer; built by Craig, Taylor and Co., Ltd., to the order of the Portfield Steamship Company, Ltd.; dimensions, 392ft. 6in. by 52ft. by 27ft. 8in. Engines, 24½in., 41in., 67in. diameter by 45in. stroke, pressure 180 lb.; constructed by Blair and Co., Ltd.; launch, August 8th.

GEOFFREY STANLEY, motor coasting vessel; built by James Pollock, Sons and Co., Ltd., to the order of the War Department; dimensions, 90ft. by 18ft. by 7ft. Engine, 90 B.H.P., two-cylinder, Plenty-Still; constructed by the builders; delivered recently.

BEAUFORT, steam-driven tanker; built by Barclay, Curle and Co., Ltd., to the order of Biorn, Biornstad and Co., Oslo; dimensions, 400ft. by 52ft. 6in. by 30ft. 6in.; 8200 tons deadweight. Engines, one set of triple-expansion, 25in., 42in., 71in. diameter by 48in. stroke; constructed by the builders; trial trip, August 20th.

CORGLEN, steel screw collier; built by the Cowper Dry Docks and Shipbuilding Company, Ltd., to the order of Cory Colliers, Ltd.; dimensions, 317ft. 6in. by 44ft. 3in. by 22ft.; 4250 tons deadweight. Engines, triple-expansion, 22in., 36in., 60in. diameter by 39in. stroke; constructed by George Clark, Ltd.; launch, August 20th.

CORBROOK, steel screw collier; built by the Cowper Dry Docks and Shipbuilding Company, Ltd., to the order of Cory Colliers, Ltd.; dimensions, 265ft. 6in. by 37ft. 6in.; to carry 2500 tons. Engines, triple-expansion, 19in., 31in., 52in. by 36in. stroke; constructed by George Clark, Ltd.; trial trip, August 21st.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE STIRLING BOILER COMPANY, Ltd., has recently appointed as its general manager Mr. George Summers, who has been associated with the company for twenty-two years.

BELL'S ASBESTOS AND ENGINEERING SUPPLIES, Ltd., asks us to announce that its head office is shortly to be transferred from London to the works at Slough, and requests that after Monday, September 2nd, all communications should be addressed to it at Bestobell Works, Slough, Bucks. Telegrams, Bestobell, Slough; telephone, Slough 830 (5 lines).

THE DEPARTMENT OF OVERSEAS TRADE, the address of which is 35, Old Queen-street, London, S.W. 1, asks us to announce for the benefit of manufacturers interested in trade with India, who may at the present time be making arrangements for their representatives to visit that market, that Major R. W. Clarke (His Majesty's Acting Senior Trade Commissioner at Bombay), and Mr. W. D. Montgomery Clarke (His Majesty's Trade Commissioner at Calcutta) are particularly anxious to meet visitors from the United Kingdom, as with their organisation they are in an excellent position to render considerable assistance either to principals undertaking a special mission of investigation, or to commercial representatives who are developing the sale of British made goods in India. The department will be pleased to provide letters of introduction to the Commissioners in question.

ERRATUM.—In the leading article on "Surge Protection on Transmission Circuits," published in our issue of August 16th, a reference was made to an article in THE ENGINEER as appearing in the issue of August 13th, 1928. The date should have been July 13th, 1928.

INSTITUTION OF NAVAL ARCHITECTS.—The following scholarships have been awarded by the Council of the Institution of Naval Architects:—Royal Commissioners for the 1851 Exhibition Post Graduate Research Scholarship in Naval Architecture (1929), £250 per annum for two years to Mr. John Henry Lamble, of Liverpool University; and Martell Scholarship in Naval Architecture (1929), £130 per annum for three years, to Mr. Robert N. Newton, of Portsmouth Dockyard.

THE INSTITUTION OF STRUCTURAL ENGINEERS: THE PORTLAND HOUSE TRAVELLING SCHOLARSHIP.—The Portland House Travelling Scholarship is awarded and governed by the Council of the Institution of Structural Engineers through a jury appointed by it. The scholarship to be awarded in 1929 will amount to the sum of £300, but it is within the power of the jury to vary or withhold the award at its discretion. Candidates for the scholarship may be Members, Associates, Associate-Members, or Graduates of the Institution of Structural Engineers who on September 14th, 1929, shall have attained the age of twenty-one years and are under the age of thirty-one years. The winner of the scholarship will be required to spend fourteen clear days on the Continent, and twenty-eight clear days in America, there to study the æsthetic and practical conditions pertaining to the uses of cements and concrete. Upon his return he will be required to submit, before July 31st, 1930, a suitably illustrated typewritten thesis of not less than 5000 words, or more than 10,000 words describing his travel and experiences. The latest date upon which applications can be received from prospective candidates is Saturday, September 7th next. Further particulars can be obtained from the acting secretary, the Institution of Structural Engineers, 10, Upper Belgrave-street, Londo S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/6 to 22/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	24/9

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 0 0	—
No. 1 Foundry	3 18 6	—
No. 3 Foundry	3 16 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 16 0	3 16 0
No. 1	3 16 6	3 16 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
Midlands—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
„ „ Foundry	3 13 6	—
3) Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 8 6	—
(1) Derbyshire—		
No. 3 Foundry	3 16 0	—
Forge	3 12 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 12 6	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 6 6 (*a*) / 4 7 6 (*b*) / 4 11 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 0 0 to 11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¾in. and up	8 12 6	7 12 6
Sections	8 2 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 7 6
Sheets (Gal. Cor. 24 B.G.)	13 17 6	13 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 12 6	—
Angles	8 2 6	—
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 2 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 2 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
Sheffield—		
Siemens Acid Billets	9 10 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	8 10 0	—
Midlands—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 10 0 to 6 15 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 12 6	—
Angles	8 2 6	—
Joists	8 2 6	—
Tees	9 2 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	208 7 6
„ „ (three months)	212 7 6
Copper (cash)	73 15 0
„ (three months)	74 10 0
Spanish Lead (cash)	23 6 3
„ „ (three months)	23 8 9
Spelter (cash)	24 17 6
„ (three months)	25 3 9
Manchester—	
Copper, Best Selected Ingots	79 5 0
„ Electrolytic	85 0 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	24 17 6
„ Foreign	23 10 0
Spelter	25 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/6½ per lb.	
Ferro Tungsten	3/3½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	7/6
„ „ 6 p.c. to 8 p.c.	£23 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£23 0 0	6/6
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£34 0 0	12/-
„ „ „ 1 p.c. carbon	£38 0 0	15/-
„ „ „ 0·70 p.c. carbon	£42 0 0	17/-
„ „ „ carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
FerroManganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£19 10 0 scale 6/- per unit	
„ Vanadium	13/- per lb.	
„ Molybdenum	4/- per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/4 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	14/6
„ „ Splint	16/6 to 18/-
„ „ Trebles	16/-
„ „ Doubles	15/-
„ „ Singles	13/- to 13/6
Ayrshire—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	16/6
„ „ Trebles	15/-
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	12/- to 15/6
Screened Navigation	17/6 to 18/6
Trebles	16/6 to 17/-
Doubles	15/-
Singles	13/-
Lothians—	
(f.o.b. Leith)—Best Steam	14/-
Secondary Steam	13/6
Trebles	16/-
Doubles	15/-
Singles	12/9

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	21/6 to 22/-
Household	38/- to 51/-
Coke	26/6 to 27/6
Northumberland—	
Best Steams	14/6 to 15/-
Second Steams	13/9 to 14/-
Steam Smalls	9/6 to 10/6
Unscreened	13/- to 13/6
Household	21/- to 26/-
Durham—	
Best Gas	16/6 to 16/9
Second	16/- to 16/6
Household	21/- to 27/-
Foundry Coke	22/- to 28/-
Sheffield—	Inland.
Best Hand-picked Branch	26/- to 27/6 —
Derbyshire Best Bright House	20/- to 22/- —
Best House Coal	19/6 to 20/6 —
Screened House Coal	17/6 to 18/6 —
„ „ Nuts	15/6 to 16/6 —
Yorkshire Hards	14/6 to 15/6 —
Derbyshire Hards	14/6 to 15/6 —
Rough Slacks	9/- to 10/- —
Nutty Slacks	7/- to 8/- —
Smalls	3/- to 5/- —
Blast-furnace Coke (Inland)	14/6 at ovens —
Furnace and Foundry Coke (Export), f.o.b.	22/- to 23/-

(9) SOUTH WALES.

	Inland.
Cardiff—	
Steam Coals :	
Best Smokeless Large	19/9 to 20/3
Second Smokeless Large	19/6 to 19/9
Best Dry Large	18/9 to 19/-
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/- to 18/3
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/9 to 18/-
Ordinary Eastern Valley Large	17/3 to 17/9
Best Steam Smalls	13/9 to 14/6
Ordinary Smalls	12/6 to 13/-
Washed Nuts	22/6 to 28/-
No. 3 Rhondda Large	20/- to 21/-
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/6
„ „ Through	15/6 to 16/6
„ „ Smalls	13/6 to 14/-
Foundry Coke (Export)	26/6 to 36/6
Furnace Coke (Export)	21/- to 23/-
Patent Fuel	21/6
Pitwood (ex ship)	38/- to 40/-
Swansea—	
Anthracite Coals :	
Best Big Vein Large	33/- to 36/6
Seconds	27/6 to 30/-
Red Vein	23/- to 27/-
Machine-made Cobbles	40/- to 44/-
Nuts	40/- to 44/-
Beans	23/6 to 25/6
Peas	19/- to 19/6
Breaker Duff	9/6 to 9/9
Rubbly Culm	11/- to 11/6
Steam Coals :	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	11/3 to 13/-
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum) 12/6

Ordinary Ship, Bridge and Tank Plates and Sections 10/- if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(*From our Correspondent in Paris.*)

Motor Cars.

On emerging from a very difficult period, the motor car industry was obliged, about two years ago, to investigate means of reorganisation which would allow of economies being effected and of cars being sold at prices that would relieve it of the threatened competition, especially from the United States. Except in high-grade cars, the competition has not proved so serious as had been feared, and the import duties are sufficiently high to protect the lighter and lower-priced vehicles which are now being produced under conditions of economy that appear to have placed the home industry in a particularly strong position. At first it was supposed that a concentration of industry would provide the most suitable means of keeping down costs. An attempt was made to concentrate five firms of good standing, each of which preserved its independence so far as manufacturing was concerned, but the commercial interests were grouped in one organisation which looked after the purchase of raw material and the sale of vehicles. Whatever may have been the results from the point of view of economy, it does not appear to have encouraged a development of business. Two of the members have since retired from the group. The situation of the great majority of makers has long been precarious, because there are far too many of them. Last year there were no fewer than seventy-seven motor car manufacturers, and as nearly 90 per cent. of the total number of cars is turned out by seven big firms, it is obvious that there can be very little for the others. Amongst them they do not produce more than 25,000 vehicles. There are a few old-established firms which continue to turn out high-grade cars for a necessarily limited class of buyers, but their activities are largely directed to commercial vehicles, the demand for which is steadily growing. As industrial concentration failed to give the results that were expected of it, the motor car industry has worked out its own salvation by mass production. There has always been a very large potential demand for cars in this country, where the roads and distances lend themselves particularly to motor traffic; but the average buyer was never quite satisfied with what was offered to him until Renault, Citroën and Peugeot, who amongst them are credited with supplying 75 per cent. of the total number of vehicles, produced types of cars that appealed to the public, which, moreover, was perfectly satisfied with the "service" rendered for ensuring the economical upkeep of cars. The demand actually exceeds the supply. Two of the above-named firms are behindhand with deliveries of some types of cars. In view of the very large class of buyers which is reached by the big firms, it is supposed that the country's purchasing capacity will absorb the whole production for some years to come. They continue to extend their manufacturing facilities, and Renault is building another big factory for coachwork. For the bodies considerable quantities of planished sheets that do not require preparation for painting are imported from the United States and Germany. Mass production does not necessarily imply an adherence to types, for the three big firms are all preparing new models for the coming Paris Show in which six and eight-cylinder engines will predominate. The four-cylinder engine is retrograding and will, as a rule, only be fitted to cars of not more than 8 horse-power. For the moment it may be said that the trade is in the hands of half-a-dozen firms, and there are many others who make commercial vehicles their special business, at the same time turning out a certain number of touring cars. Nevertheless, there is an impression that the industry is tending to become monopolised more and more by the few big manufacturers. The elimination of small makers who formerly built chassis with engines supplied by outside firms has been followed by the disappearance of petrol engine builders.

Works Improvements.

If the future of the steel trade reveals possibilities of increasing international competition, unless the markets in the East should settle down meanwhile to normal buying, steel makers are preparing to meet the situation by extending and improving their plants with the idea of reducing costs. It is stated that additional furnaces are to be put in blast and another is under construction at the Aciéries du Nord, the Aciéries de Rombas are being modernised, the Forges Demblermont are carrying out extensions, new rolling mills are being laid down at Knutange, and works are being carried out elsewhere for increasing production under modern conditions. The situation is, nevertheless, so far lacking in stability that more than ordinary interest is centred in the forthcoming meeting of the Steel Cartel. At present there is certainly an over-production of steel on the Continent, and the meeting will have to decide upon the expediency of restricting the output which was allowed to grow in view of an increasing consumption that, during the past month or two, has not been maintained. During the first six months of the present year the steel production in Great Britain, France, Germany, Belgium, and Luxemburg totalled 21,120,700 tons, or nearly a million and a-half tons more than in the first half of 1928.

Canalising the Rhine.

Following upon the agreement come to between Switzerland and Germany for canalising the Rhine between Strasburg and Basle, the Commission of the National Council appointed to make an investigation into the proposed works has carried out an inspection under the presidency of Monsieur Motta, the Swiss Minister of Foreign Affairs. Starting at Strasburg, they visited the port as well as the Alsace Canal works in progress at Kembs. The French express surprise at the decision of Switzerland to carry through the Rhine scheme at considerable expense in view of the much greater facilities which, they claim, will be offered by the Alsace Canal; but in coming to that decision the Swiss Government appears to be influenced by the necessity of doing something at once to remove a very serious hindrance to communication with the seaports. In times of drought, such as occurred last year, the traffic on the Rhine between Strasburg and Basle falls considerably.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

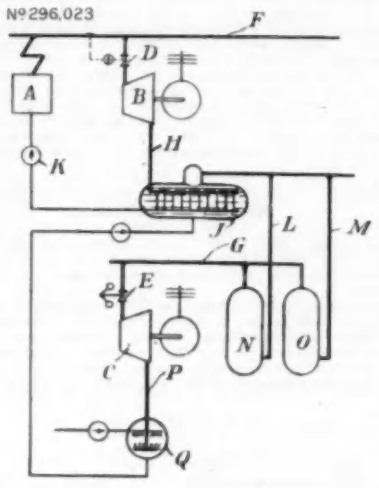
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

296,023. August 8th, 1928.—Multi-stage Steam Power Plant, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The power plant supplied with steam from boiler A comprises a high-pressure engine B running at constant load and a low-pressure engine C. The high-pressure engine B is controlled by an overflow valve D, the low-pressure engine C by an output regulator E. F is the live steam supply piping of the high-pressure engine and H the steam supply piping of the low-pressure engine. The exhaust steam of the engine B does not immediately reach the piping G through the exhaust steam pipe H, but is fed into a steam transformer J, where it is condensed while generating further quantities of steam. Its condensate is

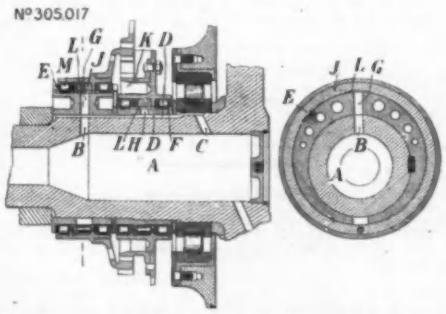


fed back to the boiler A. The steam generated in the steam transformer J is fed through pipes L and M to the accumulators N and O, to which the pipe G is connected. Let it be assumed that engine C is only working during daytime, then during night time by means of the exhaust steam of the constantly running machine B steam is constantly generated in the transformer J and this is fed into the accumulators N and O. Should at any time a load be thrown on the engine C, there is sufficient steam available in the accumulator to cover the output requirements of machine. The exhaust steam of engine C is then fed by means of a pipe P into a condenser Q and is condensed. The water, thereby already somewhat preheated, is preferably used for feeding the steam transformer J.—*July 25th*, 1929.

INTERNAL COMBUSTION ENGINES.

305,017. December 4th, 1928.—Lubrication of Valve Gear of Internal Combustion Engines of the Radial Type, Marius Jean Baptiste Barbarou, 28, Place Saint-Ferdinand, Paris.

This invention relates to a lubricating arrangement for the valve gear of engines of the radial type, which is chiefly characterised in that it comprises smooth rings which are secured to the parts of the valve gear and are provided with internal grooves co-operating with oil conduits formed in the shaft, in order to afford access of the oil to the parts to be lubricated. The lubricating oil under pressure is contained in the engine shaft A and this shaft, which is hollow, is provided with two ducts B and C for the delivery of the oil, which may thus enter a groove D on the periphery of the shaft. In the form of construction illustrated, members E and F are keyed to the shaft in such manner as entirely to close the groove D at its upper part and thus to form a recipient for the storage of the oil delivered

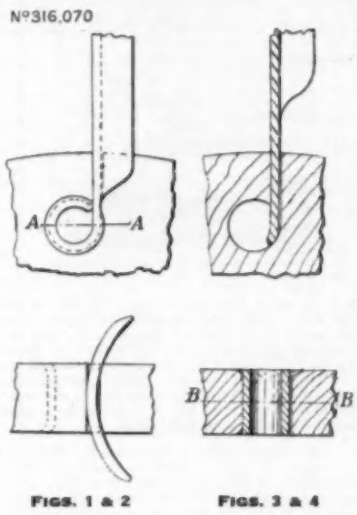


from the shaft through the ducts B and C. The members E and F are pierced with the respective ducts G and H, each of which communicates at one end with the groove D. Around each member E F is mounted by easy friction a respective smooth ring J and K, which rings are secured to the valve gear elements and have on their internal faces the respective grooves L—L co-operating with the respective ducts G and H. When the smooth rings J K have such position with reference to the shaft that the grooves L do not coincide with the ducts G and H, no oil will be supplied to the roller bearings M or to the other parts of the valve gear which are in movement. On the contrary, when the grooves L coincide with the ducts G and H, the oil will proceed from the groove D through the ducts G H into the grooves L, and hence the bearings and other parts of the valve gear in motion will be oiled.—*July 25th*, 1929.

TURBINE MACHINERY.

316,070. November 13th, 1928.—Turbine Blades and the like and Methods of Fastening the same, Arthur Offen, of 102, St. John's-road, Redhill, Surrey.

According to this invention, as applied in one form to turbine blades projecting from the periphery of a rotor or stator disc, the supporting base or disc is pierced with small holes at a suitable distance from its periphery, one hole for each blade, and narrow radial slots are cut connecting these holes to the periphery, the slots being preferably nearly tangential to the holes. The blades are forced radially into and through the slot, and their leading ends are thereby forced and guided round the peripheries of the holes until their leading edges abut against the radial parts of the blades. According to the inventor, the tubular root portion thus formed on each blade makes a secure fastening



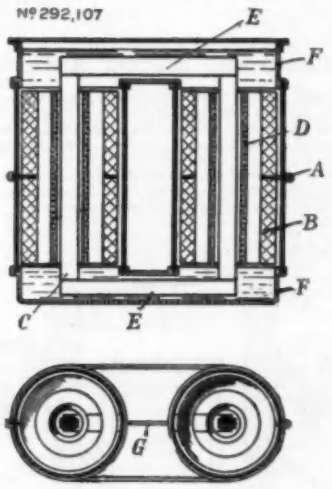
FIGS. 1 & 2 FIGS. 3 & 4

which cannot be disturbed by centrifugal force developed in the running of a high-speed turbine. The intermediate portion fits tightly in the slot and affords a rigid support for the functional portion of the blade projecting from the periphery of the disc. The blades can be extracted if and when necessary by gripping the portions projecting from the periphery of the disc and pulling radially, the tubular root portions being straightened during such process. Several alternative forms of carrying out the invention are illustrated in the specification. The drawings which we reproduce are fragmentary views, which refer to a blade fastened to the rotor disc of an impulse turbine, in which the blades are approximately transverse to the disc, Fig. 1 being an elevation, Fig. 2 a plan, Fig. 3 a section at A A of Fig. 1, and Fig. 3 a section at B B of Fig. 4, showing the blade at an intermediate position while being forced into place.—*July 25th*, 1929.

TRANSFORMERS AND CONVERTERS.

292,107. June 12th, 1928.—High-tension Transformers, Aktiengesellschaft Brown, Boveri and Cie., of Baden, Switzerland.

The type of transformer to which this invention relates is that in which the high-tension windings are arranged so that the high-tension terminals are led out from the middle of the windings and the low-tension ends of the high-tension windings are led out without being insulated from the casing. In the drawing A is a high-tension terminal of the winding B. The parts C of



the core with their low-tension windings D are situated in the main case, while the yokes E are in compartments F. It is explained that in previous arrangements of this kind only the windings have been enclosed in an oil vessel, whereas in accordance with the invention the iron yokes are oil cooled. In order that no short-circuited winding shall be formed by the iron vessel parts F F, longitudinal gaps G are provided.—*June 25th*, 1929.

TRANSMISSION OF POWER.

304,593. January 16th, 1929.—Ball Joints for Endless Tracks and Driving Chains, Richard Venzlaff, 29, Richthofenstrasse, Berlin, O. 34; Walter Agahd, 5, Joachimsthalerstrasse, Berlin-Charlottenburg, and Otto Buck, 16, Straussbergerstrasse, Berlin, Germany.

The object of the invention described in this specification is to provide a ball joint for the links of endless tracks and driving chains which, while being dust-proof and of simple construction readily allows the universal deflections of the links desirable in

such a drive. As shown in the sections through the two links and ball joint reproduced in Figs. 1 and 2, there is a pivot pin A having a centrally disposed spherical enlargement B which is engaged by a transversely divided bearing C connected to the link and arranged in an elevated position so as to engage with the driving wheel D by means of a centrally mounted spherical thrust collar E. The adjacent link is furnished with forked

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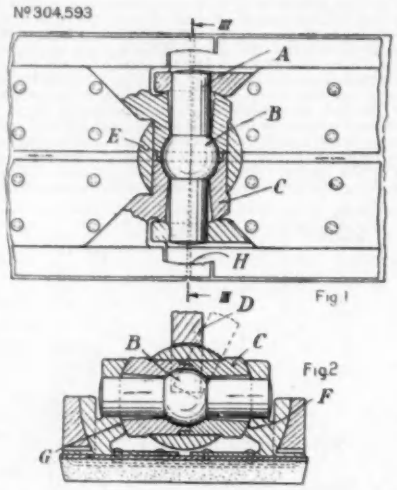

Fig 1

Fig 2

members F in which the bearings for the ends of the pin are formed. The pivot pin bearings are flared in an outward direction, and the joints G between the bearing ends and the pin supports are also spherical in shape. This arrangement, together with the spherical joints of the overlapping links H, enables the relative movement of the links about the centre of the pin enlargement to take place. The upper view, Fig. 1, shows a sectional plan, while in the lower view, Fig. 2, a transverse section through the pin is reproduced.—*July 25th*, 1929.

291,084. April 17th, 1928.—Junction and Fuse Boxes for Multi-core Cables, *Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.*

In accordance with this invention the leading-in openings A for the sockets B and the bus-bars C are arranged in inclined

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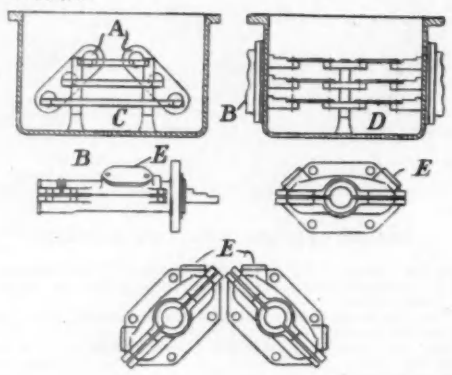

planes so that the fuses D can be removed from the box without danger of contact with the adjacent poles. The sockets B are provided with two holes E for filling the box with compound.—*July 17th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

295,256. August 7th, 1928.—Apparatus for Measuring the Variations of Pressure in Conduits Containing Water or other Liquid, *Société Anonyme Union Technique du Batiment et des Travaux Publics, of 9, Avenue Victoria, Paris.*

Variations of pressure in conduits containing water and other liquids are measured in accordance with this invention by means of the piezo-electric properties of certain crystals. In the con-

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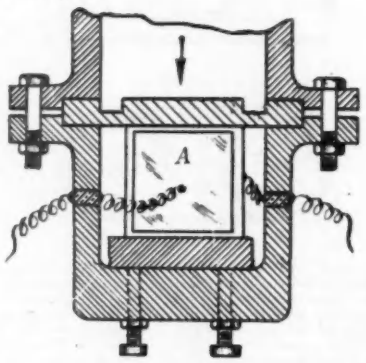


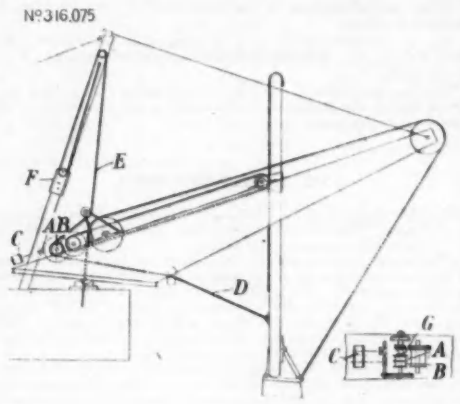
duit a piezo-electric crystal A is placed so that it is acted upon by the pressure, and the crystal is connected to an amplifier for amplifying the variations of current due to the pressure.—*July 25th*, 1929.

CRANES AND CONVEYORS.

316,075. November 24th, 1928.—Mechanical Excavators, Fleming and Ferguson, Ltd., and William Sangar Appleton, of Phœnix Works, Paisley.

This invention relates to the construction of mechanical excavators such as may be mounted on floating pontoons or wheeled carriages, and provides for the motor on the boom which is normally used for operating the dipper arm to be utilised for operating the backing rope. In the excavator shown in Figs. 1 and 2, the means for controlling the backing rope consist of a pair of interconnected winding barrels A and B which are mounted on the boom adjacent to the dipper arm

No 316,075



operating motor C and present two rope receiving sections. The barrel A is wrapped by the backing rope D, while barrel B is wrapped by a rope E attached to the counterweight F, which is arranged to slide up and down one leg of the derrick frame. A dog or friction clutch G is used to connect the barrels to their shaft. When this is disengaged the barrels run free on their shaft and permit the backing rope attached to the dipper arm to follow it during extension and recession without allowing the rope to get into destructive kinks or to sag unduly. As shown in the small plan arrangement, Fig. 2, the design enables the motor operating the dipper arm also to be used for the backing rope.—*July 25th*, 1929.

MISCELLANEOUS.

290,633. May 15th, 1928.—Transformers for Supplying Electric Current to Discharge Tubes, Dr. Dietz and Ritter G.m.b.H., of Eichstädtstrasse 9, Leipzig, O. 27, Germany.

This invention relates to apparatus for supplying the current for gas discharge tubes. An iron yoke for the reception of the stray lines of force is arranged at a slight distance from the iron core, and the object of the invention is to construct this iron yoke so that it can be subsequently applied to transformers of the usual type of construction. An iron yoke A is mounted on the

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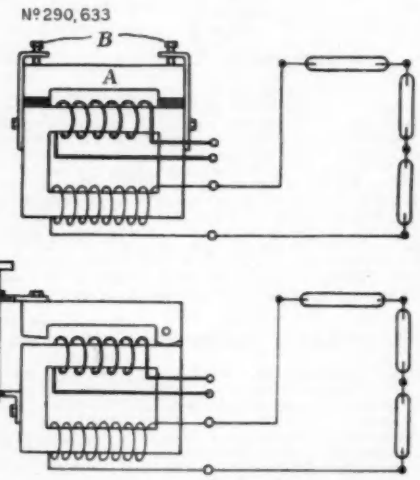
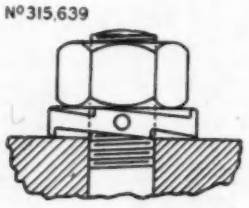


iron core by means of two screws B, and between the yoke and core there are thin discs of non-magnetic material, such as glazed cardboard. The gap between the core and yoke can be adjusted and consequently the magnetic leakage can be varied. If the secondary coil is short-circuited, a strong primary leakage fuse is produced and undue heating cannot occur. An alternative form of construction is shown in the lower illustration, which is self-explanatory.—*July 25th*, 1929.

315,639. October 17th, 1928.—Locking Washers, O. V. Jensen, 30, Livjägergade, Copenhagen, Denmark.

This locking washer is of the spring type, but is a complete

No 315,639

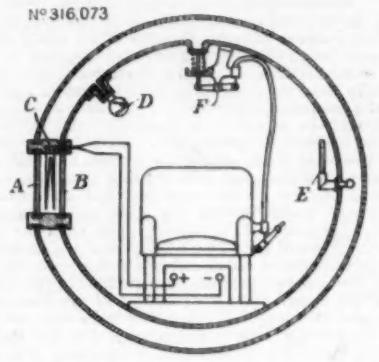


disc. The springiness is provided by staggering the teeth on opposite sides of the disc, as shown in the drawing. Holes are made in the edge of the washer for the insertion of a tommy-bar, so that it may be turned together with the nut.—*July 18th*, 1929.

316,073. November 22nd, 1928.—Cabins for Aircraft, Asmus Hansen, of 4, Akazienstrasse Schoneberg, Berlin, Germany.

As the accompanying illustration shows, this invention relates to draught-proof gas-tight cabins for aircraft, the object of the inventor being so to construct such cabins that equitable pressure and temperature conditions are maintained within it, no matter at what altitude the aircraft may be flying. As shown, the cabin is provided with an outer and an inner wall with a gas-tight intermediate space between them. A and B are window panes forming another gas-tight cell, within which there is an electric radiator C connected to a suitable source of current. This arrangement prevents the dimming of the window panes by moisture or frost. Connected to the main space between the outer and inner walls there is a pressure gauge D, a thermometer E, and a pressure regulating valve F, which may be operated as indicated by a Bowden brake wire or other suitable means. The

No 316,073



pressure in the intermediate space between the outer and inner walls of the cabin is adjusted to a value intermediate between the values of the internal and external pressures. The observation of the pressure and temperature of the gas imprisoned between the outer and inner cabin walls provides a means of checking the staunchness of the cabin.—*July 25th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Municipal and County Engineers.—South Midland District Meeting at Kempston Hardwick and Woburn, Beds. 11 a.m.

WEDNESDAY, SEPTEMBER 4TH.

Institution of Municipal and County Engineers.—Union Board Room, Wimborne. South-Western District meeting. 11.30 a.m.

SATURDAY TO SATURDAY, SEPTEMBER 7TH TO 14TH.

Model Engineer Exhibition, Royal Horticultural Hall, Vincent-square, Westminster, London, S.W. 1.

MONDAY TO SUNDAY, SEPTEMBER 9TH TO 15TH.

Institute of Metals.—Annual autumn meeting, Düsseldorf, Germany. Monday, September 9th, in the Aula of the Lessing Oberrealschule, Ellerstrasse, Düsseldorf, 5 p.m. Eighth autumn lecture, by Dr. A. G. C. Gwyer, B.Sc., "Aluminium and its Alloys." Tuesday, September 10th, 9.30 a.m., in the Hall of the Eisenhüttenhaus, Verein Deutscher Eisenhüttenleute, 27, Breitstr., Düsseldorf. Reading and discussion of paper (see page 66, July 19th, 1929). Wednesday, September 11th, 9.30 a.m., in the Hall of the Eisenhüttenhaus, Verein Deutscher Eisenhüttenleute, 27, Breitstr., Düsseldorf. Reading and discussion of paper (see page 66, July 19th, 1929). Thursday, September 12th, 8.15 a.m., whole-day excursion to Messrs. Krupp, Essen. Friday, September 13th, to Sunday, September 15th, visits to Berlin and Holland.

TUESDAY TO FRIDAY, SEPTEMBER 10TH TO 13TH.

Iron and Steel Institute.—Autumn meeting at Newcastle-on-Tyne.

THURSDAY TO SATURDAY, SEPTEMBER 12TH TO 28TH.

Shipping, Engineering and Machinery Exhibition, Olympia.

SATURDAY TO SATURDAY, SEPTEMBER 14TH TO 28TH.

Institution of Naval Architects.—Summer meeting in Italy. For programme see page 380, April 5th, 1929.

FRIDAY AND SATURDAY, SEPTEMBER 20TH AND 21ST.

Institution of Water Engineers.—Informal autumn meeting. Visits to the works of the Wakefield and Barnsley Corporations.

CONTRACTS.

The General Electric Company, Ltd., Magnet House, Kingsway, W.C. 2, has received an order from the Auckland Transport Board for 104 tramway motors, each rated at 40 B.H.P. 500 volts, on the one-hour rating. The motors will be fitted with roller type armature bearings. The order also includes the supply of resistances, lighting arresters, &c.

The English Electric Company, Ltd., has received a further order from the Central Electricity Board for two 15,000-kVA, 132,000-volt, three-phase transformers for the Central Scotland Scheme, for installation at Saltcoats. The two units will each be provided with on-load tap-changing equipment, and will be similar to the four 15,000-kVA and four 10,000-kVA three-phase units already ordered. The same company has also received from the Central Electricity Board an order for 33 kV metal-clad switchgear for the North-West England National Electricity scheme. The order, which is of the value of over £80,000, covers 39 units, of which 29 are Class O.L.F., with a rupturing capacity of 500,000 kVA, and 10 Class O.L.G., having a rupturing capacity of 750,000 kVA, together with protective gear, control boards, cabling, batteries, handling gear, L.T. auxiliary switchgear, &c.